ENGINEERING EVALUATION/COST ANALYSIS

University of Portland River Campus Property aka Triangle Park Removal Action Area within the Portland Harbor Superfund Site

Portland, Oregon

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EXECUTIVE SUMMARY

AMEC Environment & Infrastructure, Inc. (AMEC) has prepared this Engineering Evaluation/Cost Analysis (EE/CA) on behalf of the University of Portland (UP) for the UP River Campus Property also known as the Triangle Park Removal Action Area within the Portland Harbor Superfund Site (the site). The Portland Harbor Superfund Site is listed on the National Priority List (NPL). This EE/CA summarizes historical analytical data for the site, presents an analysis of removal alternatives being considered for cleanup of the site, and describes a recommended removal action. This EE/CA and supporting investigations were undertaken by UP as a Bona Fide Prospective Purchaser, as defined by Section 101(40) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. § 9601(40), in cooperation with the U.S. Environmental Protection Agency (EPA), and pursuant to the Bona Fide Prospective Purchaser Agreement and Order on Consent for Removal Action, Docket No. CERCLA-10-2007-0027 (BFPPA).

In 2006, UP entered into an agreement with the former property owner to purchase the property then referred to as Triangle Park. UP during this same period entered into the BFPPA with the EPA, and entered into a separate Prospective Purchaser Agreement (PPA) with the Oregon Department of Environmental Quality (DEQ). UP finalized purchase of the property in December 2008. Under the terms of the BFPPA, the parties have agreed that removal action work at the site must be performed with EPA oversight and be consistent with CERCLA, the National Oil and Hazardous Substances Pollution Contingency Plan promulgated pursuant to Section 105 of CERCLA, 42 U.S.C. § 9605, and codified at 40 CFR Part 300 (the NCP) and EPA CERCLA removal action guidance.

The UP River Campus property is located in the University Park area of Portland, Oregon, along the north shore of the Willamette River, approximately 4.5 miles northwest of downtown Portland. The property is located on a terrace above the Willamette River and is generally flat except for at its steeply sloped river shoreline. The property is currently vacant and is not being used, but UP plans to redevelop the property for use as part of the larger UP campus. Under UP's vision for the property, the site will be redeveloped in phases, subject to review and approval of a final Master Plan for the property by the City of Portland. Planned redevelopment of the property ranges from landscaping and greenway restoration to construction of academic and maintenance facilities, parking facilities, a practice sports field, a rowing team dock, upland boat storage, and a new baseball stadium.

The site has a long history of industrial use since the early 1900s, including wood processing and product manufacturing, cooperage storage, marine operations and storage, chemical operations, scrap salvage storage, welding operations, hazardous waste storage (including waste oils, solvents, and other materials), and concrete manufacturing. Underground and aboveground storage tanks are known to have been formerly present at the site. For all practical purposes, the site has been vacant since at least 1997, and all structures associated with former industrial activities at the site were demolished and removed by 2009.

In 1997, Triangle Park, LLC (Triangle), purchased the site from Edward Hostmann, Inc., under a State of Oregon PPA with the DEQ. The PPA conditionally limited Triangle's liability to the State of Oregon to $750,000 for investigation and cleanup of the property (DEQ, 2005). Under the DEQ PPA, Triangle LLC was not liable for groundwater impacts at the site under state law. Triangle was also relieved of any off-site sediment liability by DEQ upon performing limited baseline sediment sampling. In 2005, DEQ issued a Record of Decision (ROD) to Triangle to remediate soils at the site as part of the 1997 State of Oregon PPA between DEQ and Triangle (DEQ, 2005). Under the terms of the BFPPA entered into between UP and EPA, as well as a separate PPA with DEQ, that led to UP's purchase of the property in December 2008, the parties have agreed that, at a minimum, the removal action work at the site must meet the stipulations of the 2005 ROD. The 2005 ROD required that:

- A cap be installed over soil left in place that contains concentrations of contaminants of concern (COCs) that exceed DEQ-established screening levels;
- Specified "hot spot" areas with highly elevated concentrations of contaminants of concern be excavated and the removed soils be disposed of off-site, and
- Specific institutional controls be put in place, including proprietary controls (in the form of a DEQ-approved Easement and Equitable Servitude) and a DEQ-approved Soils Management Plan.

These remedies mandated by DEQ in the 2005 ROD were required to reduce or prevent possible exposures of human and ecological receptors to contaminated soil at the site.

In preparing this EE/CA, analytical data were reviewed from historical investigations conducted at the site, as well as from a data gaps investigation performed by AMEC in 2009 and 2010. These investigations indicate that much of the soil at the site is impacted with non-source-specific COCs, resulting in widespread impacts at relatively low concentrations. The COCs that have been detected on the site have low mobility in the environment and are not expected to migrate to the Willamette River via groundwater. Potential COCs include petroleum hydrocarbons, polychlorinated biphenyls (PCBs), tributyltin, metals, polycyclic aromatic hydrocarbons (PAHs) and carcinogenic PAHs (cPAHs), and dioxins. In addition, several specific source areas, referred to as *hot spots*, were identified that have more elevated concentrations of COCs or contaminants likely to be more mobile. Potential COCs in the hot spots are similar to the widespread COCs present at low-level concentrations at the site, but concentrations are higher in these specific source areas. Based on an empirical demonstration and calculated risks of soil-to-groundwater migration, soils that will remain at the site following cleanup are not anticipated to contain concentrations of contaminants sufficient to impact groundwater. Limited groundwater impacts have been identified. Groundwater is evaluated in this

EE/CA in order to provide a baseline for future proposed groundwater monitoring, but is not considered for cleanup based on the 2005 DEQ ROD and the expectation that cleanup of specific source areas will result in improvement in groundwater quality.

The data for this site reflects soil contaminants that are present throughout the site at fairly low concentrations and that have low mobility in the environment. For the purposes of this EE/CA, the characterization of the site was divided into 27 broad areas, including 21 areas considered "uplands" areas and 6 areas considered "river shoreline" (RS) areas (immediately adjacent to the Willamette River) (see Figure 3). Each of these 27 areas was further subdivided into specific depth intervals, and each depth interval in each area was evaluated using data from multi-incremental sampling investigations. Multi-incremental sampling (MIS) provides an average concentration of COCs over a wide area for each depth interval evaluated. In addition to these MIS results, potential hot spots were evaluated using discrete samples for each potential hot spot area, in order to determine the extent and depth of each of these specific source areas.

To determine which areas of the site require action, available site analytical data (both MIS and discrete) are compared in this EE/CA to site-specific action or screening levels developed using federal and state guidelines. Areas where action is necessary to address contamination are identified via a streamlined risk evaluation performed for the site based on protection of human and ecological receptors, as well as comparison to action or screening levels. The streamlined risk evaluation is based on a conceptual site model developed in this EE/CA and follows guidance provided to UP by the EPA, as well as Oregon law, which stipulates that achieving acceptable risk levels is an appropriate standard for hazardous substance response actions. Based on the shorter durations of exposure at a college campus, an occupational/ industrial risk exposure is appropriate and remains conservative. However, soils that exceed the residential risk exposure threshold will be required to be addressed (by a limited action/minimum of institutional controls) as part of the removal action to be protective of human health. Site specific action levels are used to divide the site into areas to determine where some response action (active response and/or institutional controls) is necessary to address contamination, as follows.

- **Limited action areas:** Upland area soils with COC concentrations below active response thresholds but above levels that allow for unlimited use/unrestricted exposure (risks between 1×10^{-5} and/or hazard index (HI) = 1 based on industrial use, and 1×10^{-6} and/or HI = 1 assuming residential use) appear to warrant only limited action. Most of the Upland area soils fall into this category.

- **Active response action areas:** Areas with soils that exceed certain thresholds described below appear to warrant active responses, such as treatment, excavation, and/or capping, and if the active response leaves waste in place above levels that allow for unlimited use/unrestricted exposure, institutional controls (ICs) would also be required. Active response action areas include:

    1. River Shoreline (RS) Areas: For the RS areas, response actions need to be protective of public health and the environment, comply with the DEQ ROD cleanup requirements, comply with applicable or relevant and appropriate requirements (ARARs) to the extent practicable (or comply completely for this to be a final action), and be consistent with and contribute to the efficient performance of anticipated long term remedial actions for the greater Portland Harbor Site which encompasses this Site. Because RS soils have the potential to slough or migrate into the river and affect sediments, EPA has determined that RS area actions should also comply with the draft Portland Harbor Site Preliminary Remediation Goals (March 27, 2009) (PRGs). All the RS areas exceed the most stringent of the above as shown in Table 2, typically the draft Portland Harbor Site Preliminary Remediation Goals, and appear to warrant active response action.

    2. Portions of the Upland Areas: Active response actions are evaluated for those upland areas where the DEQ ROD requires active response, or subsequent sampling and risk assessment has identified soils posing potential carcinogenic risk greater than 1E-04, or non-cancer risks greater than an HI > 1. Note that upland area soils are not considered likely to migrate to river sediments, so Portland Harbor PRGs have not been used to guide response action decisions in Upland Areas.

- **Hot spot areas:** All areas that were designated as Hot Spots in the DEQ ROD will require active response. Two additional areas discovered during the removal assessment will also be excavated under the Hot Spot criteria.

Following these criteria, only one upland subarea (1B) was found to exceed the active response action threshold based on an occupational use scenario. Additionally, 11 uplands areas or subareas exceeded limited action levels based on an occupational risk less than 1E-4 and a HI>1 and greater than a residential-use of 1E-6 (unrestricted use level). All six RS areas exceed draft Portland Harbor PRGs and will require an active response action. The six hot spots identified in the ROD, as well as one additional hot spot, were found to fit the definition of a hot spot and were also identified for removal action. An eighth potential hot spot area did not meet the hot spot criteria but was determined to require a limited action.

To address potential risk to human health and ecological receptors posed by these areas, six potential removal action options for the site are identified in this EE/CA. These options include (1) no action, (2) institutional controls, (3) capping with institutional controls, (4) excavation of all soils above cleanup levels with off-site disposal of excavated soils, (4A) excavation of soils above cleanup levels based on occupational/industrial exposure combined with institutional controls, and (5) excavation with on-site re-use of excavated soils where practicable (primarily for RS areas). The effectiveness, implementability, and cost of these technologies are evaluated and compared, following CERCLA, the NCP and EPA guidance. Based on the results of this evaluation, the following recommended actions are identified in this EE/CA (and displayed in Figure 13):

- Limited Response Areas (Upland Areas where soils exceed cleanup levels based on residential exposure but do not exceed cleanup levels of 1E-4 risk or HI>1 based on occupational exposure): Institutional controls (Option 2) are the preferred option for these areas, consisting of an easement and equitable servitude that would prevent residential development. This option is recommended because it poses significantly fewer obstacles to implementability and is much less expensive than other options considered in this EE/CA. In addition, compared to other options, this option is considered equally effective in meeting ARARs and protecting human health and the environment over both the short and long term. UP is not proposing to use the site for residential use. Therefore leaving soils in these areas is consistent with the planned site use where risk is based on occupational use. Institutional controls provide equal protection of human health and the environment without the construction risks and costs of more aggressive actions.

- Active Response Action Areas:

  - **Upland Areas where soils exceed cleanup levels based on occupational exposure**: A combination of capping (Option 3) and re-use of excavated site soils from the shoreline areas (Option 5) is recommended for these areas, based on cost and implementability while still meeting ARARs and being protective of human health and the environment. It is recommended that the areas be capped with 2 feet of clean soil, re-using stockpiled soils excavated from the riverfront for any required backfill and for capping. Soils reused that exceed risk thresholds applied to the site may require institutional controls or capping. If the planned future use of an area includes covering the area with an equivalent capping material, such as a building or parking lot, this alternative cap is proposed in lieu of a soil cap as part of cleanup design. This recommended action will need to be combined with additional institutional controls in order to maintain long-term effectiveness. However, with institutional controls in place (such as an easement and equitable servitude, a soil management plan, a hazard communication plan, and monitoring and maintenance of the cap), this alternative is considered equally protective of human health and the environment over both the short and long term compared to other options. The more aggressive option of excavation and off-site disposal for these areas would have doubled the costs and resulted in a great deal more truck traffic through the campus and neighborhood. Managing the soil on site by capping is a preferred option, although it will require long term maintenance.

- **Areas along the waterfront where draft Portland Harbor PRGs apply (Areas RS-1, RS-2, and RS-3):** Excavation of soil and re-use of the soil on the uplands areas (Option 5), and potential capping (Option 3), are the recommended options for waterfront areas of the site where draft Portland Harbor PRGs are exceeded. Clean, imported soil will be used as backfill if required. It is assumed that most of the soil along the riverbank will be removed to eliminate potential migration of COCs from the shoreline into the river and river sediment. Soil from Areas RS-1, RS-2 and RS-3 should be compared to upland action threshold levels and evaluated for re-use in the uplands areas consistent with decisions made for the uplands. Soils re-used as backfill in upland areas of the site (Option 5). If soil exceeding the limited action thresholds is re-used as backfill or cap material in upland areas, institutional controls may need to be established to prevent unacceptable use and limit disturbance of capped areas. None of the RS Area soils exceed active response action thresholds based on risk greater than 1E-4 or HI=1 occupational risk scenario. Capping within the RS areas may be used in combination with excavation if soils above draft Portland Harbor PRGs levels or other cleanup levels are left in place.

- **Hot Spots excavation areas:** Hot spots defined by DEQ regulation are source areas that have high COC concentrations (10 to 100 times screening levels) and therefore present a risk of mobility of COCs to groundwater. Hot spots identified in the DEQ 2005 ROD are required to be excavated and soils disposed of off-site. Only one additional hot spot not identified in the DEQ ROD presents similar concerns of contaminant mobility since it fits the DEQ definition of a hot spot. As such, soil in this area is recommended to be excavated and removed for off-site disposal.

Total estimated costs to implement the proposed removal actions described above are on the order of $2,700,000. The final recommended alternative for each area will be selected by EPA after an opportunity for input from other stakeholders and a public comment period of at least thirty days in accordance with the NCP.

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ACRONYMS AND ABBREVIATIONS

AMEC E&E	AMEC Earth & Environmental
AMEC Geomatrix	AMEC Geomatrix, Inc.
ARAR	applicable or relevant and appropriate requirements
AST	aboveground storage tank
BFPPA	Bona Fide Prospective Purchaser Agreement
bgs	below ground surface
BMP	best management practice
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COCs	contaminants of concern
cPAHs	carcinogenic polycyclic aromatic hydrocarbons
CSM	conceptual site model
DEQ	Oregon Department of Environmental Quality
EE/CA	Engineering Evaluation/Cost Analysis
EES	Environmental Emergency Services
EG2	General Employment 2
EPA	US Environmental Protection Agency
ESA	environmental site assessment
Geomatrix	Geomatrix Consultants, Inc.
HI	hazard index
HSDB	Hazardous Substances Data Bank
IC	institutional controls
IH	Heavy Industrial
JSCS	Joint Source Control Strategy
MCL	maximum contaminant levels
MFA	Maul Foster & Alongi, Inc.
μg/kg	micrograms per kilograms
μg/L	micrograms per liter
mg/kg	milligrams per kilograms
MIS	multi-increment sampling
MRL	method reporting limit
msl	mean sea level
NCP	National Contingency Plan
NPL	National Priority List
O&M	operations and maintenance
ORSN	Oregon River & Steam Navigation Company
OSWER	Office of Solid Waste and Emergency Response
PAH	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
pg/g	picograms per gram

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PPA	Prospective Purchaser Agreement
PRG	preliminary remediation goal
QA	quality assurance
R2	Residential 2,000
R5	Residential 5,000
RAFLU	reasonably anticipated future land use
RAO	removal action objectives
RBC	risk-based concentrations
RCRA	Resource Conservation and Recovery Act
RES	Riedel Environmental Services
RI/FS	remedial investigation/feasibility study
ROD	Record of Decision
RS	river shoreline
RSDs	relative standard deviations
RSL	Regional Screening Levels
Sakrete	Sakrete of Pacific Northwest, Inc.
SLV	Screening Level Values
SOW	statement of work
SRE	streamlined risk evaluation
SSL	soil screening levels
TPH	total petroleum hydrocarbons
TPH-D	total petroleum hydrocarbons diesel range
TPH-O	total petroleum hydrocarbons heavy oil range
Triangle	Triangle Park, LLC
TSCA	Toxic Substances Control Act
UP	University of Portland
USFWS	US Fish and Wildlife Service
UST	underground storage tank
UU/UE	unrestricted use/unlimited exposure
VOCs	volatile organic compounds

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REVISED ENGINEERING EVALUATION/COST ANALYSIS
University of Portland River Campus Property
aka Triangle Park Removal Action Area
Portland, Oregon

1.0 INTRODUCTION

AMEC Environment & Infrastructure, Inc. (AMEC), has prepared this Engineering Evaluation/Cost Analysis (EE/CA) on behalf of the University of Portland (UP) for the UP River Campus Property (the site) (Figure 1). This EE/CA presents an analysis of removal action options being considered for cleanup of the site and describes a recommended removal action. Data from historical investigations are also presented in support of the removal action options.

UP qualifies as a Bona Fide Prospective Purchaser as defined in Section 101(40) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. § 9601(40), This EE/CA and supporting investigations were undertaken by UP, in cooperation with the U.S. Environmental Protection Agency (EPA) and pursuant to a Bona Fide Prospective Purchaser Agreement and Order on Consent for Removal Action, Docket No. CERCLA-10-2007-0027 (BFPPA). In 2006, UP entered into an agreement with the former property owner to purchase the property then referred to as Triangle Park. UP during this same period entered into the BFPPA, as well as a separate Prospective Purchaser Agreement (PPA) with the Oregon Department of Environmental Quality (DEQ). UP closed on the purchase of the property in December 2008. Under the terms of the BFPPA, the parties have agreed that the removal action work at the site must be consistent with CERCLA, the National Oil and Hazardous Substances Pollution Contingency Plan promulgated pursuant to Section 105 of CERCLA, 42 U.S.C. § 9605, and codified at 40 CFR Part 300 (the NCP), EPA removal action guidance and be performed with EPA oversight.

This EE/CA was conducted in accordance with CERCLA, including the NCP (40 CFR § 300.415). Section 300.415(b)(4)(i) of the NCP requires that an EE/CA be completed for all non-time-critical removal actions. This EE/CA was prepared following EPA's Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA (EPA, 1993). This EE/CA provides information about the nature and extent of contamination and the potential risks posed by the contaminants to human and ecological receptors. This EE/CA also identifies the proposed objectives of the removal action, analyzes the effectiveness, implementability, and cost of various options that may achieve these objectives, and identifies a recommended alternative.

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2.0 SITE CHARACTERIZATION

This section summarizes available data on the physical, demographic, and other characteristics of the site and surrounding areas to provide background engineering information for analyzing removal options. This section also sets forth the risk evaluation, action levels and identifies those areas of the site that require removal action. The overall layout of the site and historic structures are shown on Figure 2.

2.1 SITE DESCRIPTION

The 35 acre site has been investigated extensively for the past 15 years under DEQ and then EPA oversight. The following site description is based on the various reports prepared over that 15 year period. For purposes of characterizing the distribution of potential contaminants, the site has been subdivided into separate sampling areas, as shown on Figure 3 and described in detail in Sections 2.4 and 2.6.1.

2.1.1 Site Location and Legal Description

The site is located in the University Park area, along the north shore of the Willamette River, approximately 4.5 miles northwest of downtown Portland, Oregon (Figure 1). The site is an irregular-shaped tract of land occupying approximately 35 acres (1,524,600 square feet) in Section 18, Township 1 North, Range 1 East of the Willamette Meridian in Portland, Multnomah County, Oregon. The approximate center of the site is located at latitude 45°34’29.24’’N, longitude 122°44’08.09”W. The site comprises three tax parcels (R248492, R315795, and R315775). The property description is Portsmouth Addition, Block 36, lots 1 to 9, tax lots 100, 200, and 8900 (City of Portland, 2011).

The site is bounded by the Willamette River to the south and west, the former McCormick & Baxter Creosoting Company property to the northwest, the main UP campus to the east/southeast (including the area along the river to the southeast), and residential housing and Waud Bluff to the north, northeast, and east (Figure 2),

The site may be accessed from the north by North Van Houten Place, which traverses Waud Bluff and extends onto the northwest corner of the property. North Van Houten Court extends from North Van Houten Place onto the northeastern portion of the site. The site is also accessible from the south via North Bluff Street, which winds down the bluff from the southwestern extent of North Portsmouth Avenue.

2.1.2 Topography and Site Features

The site is located on a terrace above the Willamette River to the west and the 120-foot-high Waud Bluff to the east. The site is generally flat, at an elevation of 20 to 40 feet above mean sea level (msl). The 100-year floodplain is bounded at an elevation of approximately 28 feet msl, as shown on Figure 3, and occupies the western portion of the site. The Willamette River shoreline is steeply sloped, with three docks extending from the property into the river. A 200- to 300-foot embayment is located in the central shoreline, as shown in Figure 2 (MFA, 2002a).

A Union Pacific railway bisects the site from north to south (Figure 2); this railway is considered active but is rarely used. Buried utilities at the site are identified on Figure 2. An underground fuel pipeline and valve owned by Chevron are located near the southerly edge of the site. The pipeline traverses under the southern and southeastern portions of the site transporting jet fuel to Portland International Airport. Other utility lines at the site include a water line and a natural gas line. The water line runs north to south along the eastern side of North Van Houten Court. The natural gas line runs parallel to North Van Houton Court, angles to the southwest, and then proceeds west across the railway near the center of the site. The natural gas line continues west to the area of several former buildings on the west-central portion of the site. The water line proceeds south along the western side of the railway. No stormwater discharge lines currently discharge as all remaining catch basins were filled with concrete by UP upon acquisition of the property. A security floodlight line also runs east to west near the central portion of the site and northeast to southwest along the eastern side of the railway for the entire length of the site. A perimeter chain-link fence runs along the property boundaries, as well as along either side of the railway.

No aboveground structures currently exist on the site. Access roads and former parking areas on the eastern portion of the site and one former parking area on the western portion of the site are paved with asphalt. Areas of dense vegetation (including blackberry bushes and some mature trees) are present along the northwestern and northeastern site boundaries, and along the bank of the Willamette River. The remaining portions of the site are generally covered with gravel and/or grasses. The majority of concrete paving has been demolished at the site.

2.1.3 Geology

Environmental investigations at the site have identified the following geologic units (Geomatrix, 2008; AMEC E&E, 2006c; MFA, 2002a):

- **Imported fill:** The uppermost soil layer is imported fill material with a variable thickness of 10 to 16 feet. Fill (likely dredged river sand and gravel) was placed at the site in the early 1900s and along the northwestern boundary of the site in the early to mid-1970s. The upper 1 to 3 feet of fill material over most of the site generally consists of gravel. The gravel is typically underlain by fine- to medium-grained sand, generally with little to no silt. However, within the sand fill, layers of gravel, silt, sandy silt, sandblast grit, and other materials have been observed. A different type of fill material is present in the northwestern portion of the site (the areas identified later in this report as Areas 6A, 6B, 6C, and 6D). This area consists of sandy silt.

- **Recent alluvium:** Recent alluvium underlies the imported fill. The alluvium consists of gravel, sand, silt, and clay. A deep boring (WGB-6) drilled at the site indicated the recent alluvium is approximately 90 feet thick.
- **Catastrophic flood deposits:** The deep boring WGB-6 revealed coarse-grained flood deposits from the bluff east of the site at a depth of approximately 105 feet below ground surface (bgs).
- **Bedrock:** The Troutdale Formation, Sandy River Mudstone, and Columbia River Basalt Group units are present at depth beneath the catastrophic flood deposits.

2.1.4 Hydrogeology

Uppermost groundwater is typically present in the imported fill and recent alluvium (MFA, 2002a). Groundwater is typically encountered at variable depths of 9 to 25 feet bgs, depending on the season and river stage (MFA, 2001, 2002a). Water levels recorded historically indicate that groundwater flows toward the Willamette River and is tidally influenced (AMEC E&E, 2006c).

2.1.5 Climate

The site is located in Portland, Oregon, in a west coast marine environment that receives moderate rainfall. Average rainfall in Portland is 37 inches, with the majority of rain occurring between October and May. December is generally the wettest month and July is generally the driest month. Prevailing winds are generally northwesterly in the spring and summer and southeasterly in fall and winter. January is generally the coldest month, with temperatures averaging in the low 30s to low 40s degrees Fahrenheit. August is generally the warmest month, with temperatures averaging in the mid-50s to upper 70s degrees Fahrenheit (MFA, 2002a).

2.1.6 Endangered/Threatened Species, Critical Habitat, and Wetlands

A survey for the presence of threatened or endangered species and associated critical habitat was not completed by AMEC. It appears that areas designated as final critical habitat for threatened or endangered species are present on the site or adjacent. The University will work with the Services (NOAA Fisheries and US Fish and Wildlife Service) to ensure compliance with ESA. A wetlands determination or delineation was also not completed by AMEC; however, based on the USFWS online *National Wetlands Inventory Wetlands Mapper*, wetlands are not present on the site (USFWS, 2011b).

2.2 Site Background and History

Former and current uses of the site are described in this section.

2.2.1 Former Industrial Use

The site has a long history of industrial use. Figure 2 shows locations of documented historical structures at the site (GeoEngineers, 1992; MFA, 2002b). Research of historical records reveals that during the early to mid-1900s, several companies, including Standard Oil, as well as the Peninsula Lumber Co., acquired portions of the site and conducted various industrial operations. By 1909, Peninsula Lumber Co.'s wood products manufacturing facility occupied the north and northwest end of the property. At that time, the Oregon River & Steam Navigation Company (ORSN) Railroad, St. John's Branch, bisected the entire site from north to south, with the Peninsula Lumber Co. sawmill operation primarily to the west and lumber pile storage facilities to the east of the railway. The southern area of the site contained wharves and riverfront tanks associated with Standard Oil's business activities (AMEC E&E, 2006a).

As of the mid-1920s, the Peninsula Lumber Co. sawmill remained operational at the northwest end of the site. Between 1909 and 1924, several new facilities were constructed on the site:

- A large offshore dock was built parallel to the shoreline along the sawmill property.
- The Peninsula Ship Building Co. began operations on the southern boundary of the Peninsula Lumber Co. facility. The shipbuilding operation included four large piers that began directly southwest of the railway and extended into the Willamette River. Immediately east of the piers on the opposite side of the railway, the Peninsula Ship Building Co. maintained a boiler room, paint and iron storage areas, and a machine shop.
- Fenner Manufacturing Co. built a additional sawmill facility at the extreme north end of the site along the eastern side of the ORSN rail line in an area formerly occupied by lumber piles.
- Portland Railway Light and Power Co. built and maintained a power plant fired by oil, coal, and refuse along the eastern boundary of the site. This facility was located east of the railway at the base of the bluff.
- At that time in 1924, Standard Oil Co. retained a sparsely developed parcel with a vacant warehouse at the southernmost end of the site. The vacant warehouse was served by a 6-inch-diameter water line that ran across the site to the Portland Railway Light and Power Co. plant.

Throughout the 1930s and 1940s, wood processing, cooperage storage, and marine operations were the major industrial activities associated with the site. By 1950, the Western Cooperage Co. occupied a warehouse on the eastern side of the railway in the former Peninsula Ship Building Co. industrial area. At this time, Willamette Tug & Barge Co. owned the southernmost parcel of land formerly used by Standard Oil Co. Willamette Tug & Barge Co. stored marine equipment and conducted marine operations from this property until at least 1975. As of 1950, Peninsula Lumber Co. was replaced by the Wilson River Lumber Co.

By 1950, only the operational buildings west of the railroad remained. Buildings associated with Fenner Manufacturing Co. on the east side of the railway no longer existed, and the Peninsula Shipbuilding Co. piers had been removed. At that time, the property between Wilson River Lumber Co. and Willamette Tug and Barge Co. was vacant except for a single office building. Occupant records also indicate the presence of Willamette Hi-Grade Concrete Co. on the site by at least 1950 (GeoEngineers, 1992).

During the 1950s and 1960s, site records show that Willamette Hi-Grade Concrete Co., Willamette Tug and Barge Co., and various wood product manufacturing and storage companies maintained property ownership at the site. Additionally, new industry established at the site included Evergreen Chemical and Soap Co., which ran its operations from 1952 through at least 1963 (GeoEngineers, 1992). By 1969, Oregon Woodworking Ltd. occupied northern areas of the site on both sides of the railway. A scrap salvage storage yard, general storage buildings, and a building used for welding operations were located on the former Peninsula Ship Building Co. property. By 1969, Willamette Hi-Grade Concrete Co. owned the land previously occupied by Portland Railway Light and Power Co. on the east side of the railway as well as property stretching southwestward to the Willamette River. The southern extent of the site remained in the possession of Willamette Tug & Barge Co. for maritime storage as well as other maritime operations. Willamette Tug and Barge Co. continued operations until at least 1975.

During the 1970s, land ownership records indicate Willamette Hi-Grade Concrete Co. and Sakrete of Pacific Northwest, Inc., produced concrete on the site. Western Pacific Dredging Co. and Willamette Western Corporation also owned property at the site from 1970 until at least 1975. In the 1980s, primary land owners at the site included Riedel Industries and Sakrete of Pacific Northwest, Inc. Riedel Industries' main business was dredging river bottoms, pole driving, and marine construction (DEQ, 2011). In 1972, Riedel became involved in cleanup of hazardous waste spills, especially near railroads. Riedel Industries created a division called Environmental Emergency Services (EES), which completed a Resource Conservation and Recovery Act (RCRA) part B permit in 1984 to build a large hazardous waste storage building. Neighbors protested the storage area so vehemently that the City of Portland refused to grant a conditional use permit, and EES decided to close the storage area and move it to another location (off-site). In 1984, soil contaminated with polychlorinated biphenyls (PCBs) was excavated from a location near North Bluff Street on the southeastern edge of the site.

By the early 1990s, the southern end of the site contained an office building for Riedel Environmental Services (RES). Other structures located within this portion of the site included an oil spill response warehouse, and the remnants of both a concrete batch plant and a truck weigh station. Various small storage buildings and a warehouse (former power plant) were present in the central portion of the site east of the railway. A concrete pad in front of the warehouse covered underground fuel storage bins formerly associated with the power plant's energy production. The converted power plant was positioned either directly upon or at least proximate to the historic Portland Railway Light and Power Co. property. Metal parts, dredging equipment, pumps, engine parts, paint, and other equipment were stored in these buildings. Immediately north of the former power plant were buildings that previously held stored waste oils and solvents. This area was also utilized as a storage area for approximately fifty, 55-gallon drums. In 1992, several of the drums were observed to be rusted through and leaking while other drums were bulging and full. South of the warehouse were two non-operational underground storage tanks (USTs) and two active aboveground storage tanks (ASTs) (GeoEngineers, 1992).

On the west side of the railway, a concrete slab and steam-cleaning facility provided an area for washing equipment used by RES for cleanup operations. Stored oily waste containers were also observed at this location by GeoEngineers in 1992. At the northern end of the site, excavated former USTs, as well as former ASTs, dredge piping and equipment, heavy equipment, and various types of metal debris were stored (GeoEngineers, 1992). Transformers and large steel tanks were also kept in this area of the site. An old brick drying kiln served as a storage building for scrap metal and small equipment.

By the early 1990s, the site was served by three docks along the Willamette River. General marine equipment, tugs, dinghies, boats, and barges were kept at these docks or moored offshore (GeoEngineers, 1992). From that time to the present, Chevron has maintained a pump station and fuel line at the southernmost end of the site that supplies jet fuel to the Portland International Airport, located several miles to the north.

Most of the structures at the site were demolished in the 1990s. The remaining structures were removed in 2009 by UP under EPA oversight in accordance with a demolition work plan (AMEC Geomatrix, 2009) approved by EPA.

2.2.2 Triangle Park Prospective Purchaser Agreement

In 1997, Triangle Park, LLC (Triangle), purchased the site from Edward Hostmann, Inc., under a State of Oregon PPA with the DEQ. The PPA conditionally limited Triangle's liability to the State of Oregon to $750,000 for investigation and cleanup of the property (DEQ, 2005). For all practical purposes, the site has been vacant since at least 1997. From 1998 to 2004, Triangle conducted a remedial investigation/feasibility study (RI/FS) under DEQ oversight (MFA, 2004, 2004b). In 2005, DEQ issued a Record of Decision (ROD) to Triangle, pursuant to state law, to remediate soils at the site (Section 2.2.4). Under the DEQ PPA, Triangle was not liable under state law for groundwater impacts at the site. Triangle was also relieved of any off-site sediment liability by DEQ upon performing limited baseline sediment sampling.

2.2.3 University of Portland Bona Fide Prospective Purchaser Agreement

In December 2006, UP entered into a BFPPA with the EPA, as well as a separate PPA with DEQ, that led to UP's purchase of the property in December 2008. The BFPPA statement of work (SOW) requires completion of an EE/CA. Under the BFPPA, the removal action work at the site must be consistent with EPA removal action guidance under CERCLA and performed with EPA oversight. The SOW also requires that UP conduct a technical briefing to EPA, DEQ, concerned Tribes, and the Willamette River Trustees to outline the proposed removal options that will be presented in the EE/CA. This technical briefing will be scheduled after EPA completes its review of this EE/CA. Based on results from the technical briefing, the EE/CA will be updated as necessary and submitted for approval to EPA. Upon approval by EPA, the EE/CA will be issued for formal public comment. The SOW specifies the sections and topics that must be included in this EE/CA.

As part of the BFPPA, subject to certain conditions, the United States covenants not to sue or take administrative action against UP for existing contamination at the site. Likewise, UP (and its contractors and employees) covenants not to sue or assert any claims or causes of action against the United States with respect to existing contamination, work at the site, oversight costs, or the BFPPA.

2.2.4 Oregon Department of Environmental Quality Record of Decision

DEQ's 2005 ROD findings described low concentrations of contaminants of concern (COCs) present throughout the site, interspersed with specific source areas with higher concentrations of COCs. These isolated source areas were identified in the ROD as "hot spots." In general, relatively low concentrations of petroleum hydrocarbons, PCBs, metals, polycyclic aromatic hydrocarbons (PAHs), and dioxins are present throughout the site. The COC sources derived from long-term industrial activities at the site including periodic imported fill placed at the site. Grading activities may also have spread and diluted contamination from original source areas into soils across the site. The source areas or hot spots contain chiefly petroleum hydrocarbons and PAHs, although some also contain other COCs.

The 2005 ROD established cleanup levels (Table 3) and specified that the hot spot areas be excavated, and the excavated soils be disposed of off-site. The ROD also required that a cap be installed over the remaining soil containing concentrations of COCs that exceed DEQ-established screening levels. These remedies were required to reduce or prevent possible exposures of human and ecological receptors to contaminated soil at the site. The 2005 ROD imposed specific institutional controls (ICs), including a deed restriction (in the form of a DEQ-approved Easement and Equitable Servitude) and a DEQ-approved Soils Management Plan that includes procedures to address four issues:

1. Notifying workers at the site about the presence of soil contamination;

2. Characterization, management, and disposal of waste soil (should it be generated in the future);
3. Maintaining residual concentrations of contaminants in newly exposed surface soil (0-3 feet bgs) at levels protective of human and ecological (terrestrial and aquatic) receptors; and
4. Health and safety requirements related to currently existing contaminated soil for any future site redevelopment activities.

DEQ's 2005 ROD notes that while shallow groundwater has been minimally impacted by releases from historic site operations - any residual soil contamination remaining on site after soil cleanup is completed is not expected to significantly impact groundwater in the future. The 2006 PPA also specifies that DEQ will retain liability for any impacts on groundwater.

The majority of the work outlined in the DEQ ROD, including excavation of approximately 800 cubic yards of soil hot spots, capping of approximately 5,000 square yards of residual contaminated soil, and implementation of institutional controls, has not yet been implemented pending the ongoing CERCLA removal action process overseen by EPA. Consistent with the BFPPA, the DEQ ROD mandated action is expected to be implemented as part of this CERCLA removal action.

2.3 Current Use and Reasonably Anticipated Future Land Use

This section describes current use of the property and summarizes reasonably anticipated future land use (RAFLU). This discussion of land use provides the basis for assumptions used in the risk assessment, informs definition of removal action objectives, and will inform selection of the final remedy. A complete Reuse Assessment has been completed pursuant to EPA requirements and is included as Appendix A. This section summarizes the most important elements of the Reuse Assessment.

2.3.1 Current Use

The site is currently vacant and is not being used. UP controls the site and has fenced it and implemented erosion controls to minimize access and exposure to the site soils pending completion of the EE/CA and removal actions. The site was historically zoned for Heavy Industrial (IH) use.
In January 2009, the zoning was changed to General Employment 2 (EG2) to accommodate UP's future anticipated use of the site. Adjacent properties to the north/northwest, east/northeast, and east/southeast of the site are zoned IH, Residential 5,000 (R5), and Residential 2,000 (R2), respectively. The site is bounded to the northwest by the former McCormick & Baxter Creosoting Company CERCLA site, to the east/northeast by Waud Bluff and residential properties, to the east/southeast by the main UP campus and residential properties, and to the south/southwest by the Willamette River.

Chevron currently holds an easement for an underground petroleum fuel line that runs across the southeastern portion of the site. No other institutional controls, including easements and covenants, are known to be currently in place on the site. Engineering controls currently in place at the site include a chain-link fence surrounding the site; security lights installed along the railroad on the eastern portion of the site; and stormwater/erosion control best-management practices (BMPs), including sediment fencing, straw wattles, and plastic sheeting over stockpiles of fill material.

2.3.2 Reasonably Anticipated Future Land Use

UP plans to redevelop the site for use as part of the larger UP campus. A schematic layout of the anticipated future redevelopment is presented in Figure 4, which is based largely on a land-use analysis prepared by UP (UP, 2008). It is our understanding that the entire site will be redeveloped to some extent, with activities ranging from landscaping and greenway restoration to construction of new buildings, parking areas, and ballfields. The final River Campus Plan needs to be approved by the City of Portland through a formal planning process. Therefore, ultimate development of the River Campus could change from the current concept described in this report. In addition, construction timing will depend on UP's financial capacity to expand the campus.

The current UP redevelopment plans include construction of the following facilities:

- A new environmental learning center building encompassing a large portion of Area 5A;
- Paved parking areas associated with the environmental learning center covering most of the remaining portions of Area 5A;
- Physical plant/shop/office building and physical plant vehicle parking shed in Area 1B;
- Print shop and storage facility building in Area 1A;
- Tennis facility building in Areas 6D1 and 6D3;
- Event ticket building in Area 6D2;
- A new crew house building in Area 4 and/or RS-3;
- New baseball stadium over portions of Areas 6D2, 6D3, 6A, 6B, and 5B, and a new baseball practice facility in Area 5B;
- Recreational softball fields; and
- A pedestrian trail running generally along the current shoreline.

UP intends to demolish the existing baseball stadium located on the upper campus to accommodate several major new developments on its upper Bluff campus (library expansion in 2012 and a new

Recreation/Wellness Center groundbreaking in 2013). UP also plans to construct a new sports practice field with associated paved parking areas on the southern end of the River Campus beginning in spring 2012. In addition, UP has begun discussions with its Athletic Department administrators to finalize plans to begin construction in the summer of 2012 of a new NCAA Division-1 baseball field in the northwest quadrant of the River Campus. The field will be enhanced with lighting, outfield fences, batting facility, team dugouts, temporary bleacher seating, and adjacent paved parking lots. UP hopes to have the new baseball field and other amenities ready to host practices and games by the summer of 2013. Construction of a new baseball stadium with permanent seating will follow in 2 to 3 years depending on the availability of funds.

Development of the proposed City of Portland pedestrian trail will depend on final decisions regarding habitat restoration along the shoreline. Habitat restoration is separate from the removal action process or the BFPPA, but may be implemented at the same time as the removal action work. Any habitat restoration must be approved and coordinated with other agencies, including the Trustees for the Portland Harbor NPL-listed Superfund Site.

To reiterate, the zoning designation for the site has recently been changed from heavy industrial general employment to accommodate UP's future use of the site. The site will no longer be used for industrial purposes. UP does not intend to use the site for residential purposes or daycare facilities.

2.3.3 Recontamination Potential

Under Oregon law, it is necessary to evaluate the potential for recontamination of the site after the removal action is completed. Recontamination can occur through the inadvertent spreading of remaining contaminated soil or via migration of contaminated groundwater. As UP intends to develop the River Campus site for use as part of the planned larger campus, the risk for recontamination due to future activities at the site is low. This EE/CA will evaluate the risk of exposure to site contaminants. The identified environmental risks to human health and the environment will be addressed through removal actions developed in this EE/CA. The removal actions must be designed to eliminate the potential for recontamination.

The DEQ ROD assumed that final cleanup actions on the site would include institutional controls, capping of contaminated soils, excavation and reuse of slightly contaminated soils, removal (excavation and off-site disposal) of contaminated soils, or a combination of these actions. These removal action technologies are assessed in this EE/CA along with other potentially applicable technologies. These removal actions should prevent recontamination and are considered appropriate options because:

- Surface material remaining at the property would not contain residual concentrations of contaminants at concentrations greater than cleanup levels (i.e., any residual contamination will be capped or will be present at sufficient depth that it will not be exposed to potential wind or surface water runoff, and/or institutional controls will be in place that limit site use).

- The most highly impacted soil would be excavated, and would therefore not pose the potential for recontamination of soil or groundwater.
- Institutional controls (e.g., restrictions on subgrade excavation and long-term operation, monitoring and maintenance plans) would be in place to ensure that site uses are consistent with the required actions. In addition information must be provided to future users regarding precautions that may need to be implemented to prevent recontamination and exposure to receptors. Actions such as caps must be adequately monitored and maintained.
- No upgradient contamination sources have been identified that pose a recontamination threat to the site.

Sections 4 through 6 develop and evaluate removal action options to address contamination on the site, including the potential for recontamination.

2.4 PREVIOUS INVESTIGATIONS

Environmental investigations have been conducted at the site since the 1980s to document areas affected by releases of hazardous substances from historical industrial activities. The locations of sampling points used during the various environmental investigations at the site are shown in Figure 3.

Riedel began investigations at the site in 1986 as part of facility closure under RCRA. This investigation identified PCB contamination in shallow soils and recommended removal of the upper 1 foot of soil over limited areas of the site. Site investigations continued in the 1990s, and included the following studies:

- A Phase I (GeoEngineers, 1992) and focused Phase II (EMCON, 1993) Environmental Site Assessment (ESA) identified the presence of PAHs, carcinogenic PAHs (cPAHs), and arsenic above screening levels in soil; PAHs/cPAHs and metals (antimony, beryllium, lead, and copper) in selected groundwater wells; and diesel in soils near locations where USTs had been removed.
- EMCON (1993 and 1995) documented the removal of USTs. Confirmation sampling indicated the presence of petroleum hydrocarbons in soil at concentrations greater than screening levels.
- A preliminary site assessment (DEQ, 1995) identified the following contaminants at concentrations of concern: arsenic, PCBs, petroleum hydrocarbons, cPAHs, and chlorinated hydrocarbons in soils, and metals (arsenic, antimony, beryllium, chromium, copper, lead, and nickel) and petroleum hydrocarbons in groundwater. The assessment

also concluded that further investigation was necessary to better define the nature and extent of soil and groundwater contamination.

- A baseline sediment assessment (MFA, 1997) conducted on behalf of Triangle determined that shallow sediments adjacent to the site contained concentrations of copper, tributyltin, motor oil, and PAHs/cPAHs above screening levels. The sediment assessment noted that other potential sources of copper and PAHs/cPAHs had been identified during investigations of upstream and nearby sediments conducted for nearby facilities. This investigation satisfied Triangle's requirement under the 1997 PPA to perform limited baseline sediment sampling prior to being relieved of any Oregon State related off-site sediment liability.
- An RI was conducted from 1999 to 2002 (MFA, 2002a). DEQ approved the RI work plan in April 1999, and the initial field work for the RI was conducted in mid-1999. Phase II RI field work was conducted in spring 2000. During the RI field effort in June 1999, DEQ worked with MFA, Triangle's consultant, to collect approximately 20 grab groundwater samples. DEQ officially designated groundwater and sediments at site to be an Orphan project in March 2001, so Orphan funds could be used to pay for groundwater and sediment investigation and cleanup. MFA completed a *Beneficial Water Use Determination* (MFA, 2001a) and a *Land Use Assessment* (MFA, 2001b) for the site in December 2001. MFA submitted a human health risk assessment report in December 2002 (MFA, 2002b).

The findings of these investigations informed the FS conducted between 2002 and 2004 (MFA, 2002a, 2004a,b), which was overseen by the DEQ and concluded with a Record of Decision (DEQ, 2005). Based on the 1997 PPA between Triangle and the DEQ limiting Triangle's liability under Oregon law to soil, the RI/FS was conducted for soil only. The RI/FS concluded that much of the site is impacted with non-source-specific COCs in soil, resulting in widespread impacts at relatively low concentrations. These COCs include PCBs, metals, volatile organic compounds (VOCs), PAHs/cPAHs, petroleum hydrocarbons, chlorinated phenolics, and dioxins/furans. In addition, several specific source areas were identified, referred to by the DEQ as hot spots. The RI/FS resulted in selection of remedial actions specified in the ROD and described more fully in Section 2.2.4. Most of the work outlined in the DEQ ROD has not yet been completed pending EPA's ongoing removal action process.

The EPA removal action process was initiated during preparation of the BFPPA for UP's purchase of the property. As part of developing the BFPPA, AMEC Earth & Environmental (AMEC E&E) performed a multi-increment sampling (MIS) investigation in 2006 on behalf of UP. The MIS investigation was conducted pursuant to a Settlement Agreement with EPA in order to thoroughly evaluate remaining site risks and evaluate what portions of the property may warrant additional removal actions (AMEC E&E, 2008). The MIS approach was selected in order to more fully characterize potential risk due to widespread impacts of the COCs found at low levels in the earlier studies.

The MIS approach evaluates contamination over a relatively wide area based on analysis of composite samples prepared from discrete samples collected over the entire site. Based on historical site use and data from previous investigations, the site was subdivided into 17 areas for MIS characterization: Areas 1A, 1B, 1C, 2A, 2B, 3A, 3B, 4, 5A, 5B, 6A, 6B, 6C, 6D, RS-1, RS-2, and RS-3 (Figure 3). Within each MIS area, 30 samples were collected via push boring at three depth intervals: 0-1 foot, 1-5 feet, and 5-10 feet bgs. For each depth interval within each sampling area, the 30 discrete samples were composited into a single sample and analyzed following the MIS method (Gerlach and Nocerino, 2003) to identify contaminants of concern for each depth interval within each area. The surface multi increment soil sampling (0-1 foot) was conducted to address three objectives:

- Obtain data on concentrations of COCs in soil;
- Use these data to evaluate the likely risk to human health and ecological receptors from direct contact with contaminated surface soil; and
- Evaluate the potential for contaminants in soils at the site to migrate via stormwater to adjacent river sediments at concentrations above acceptable risk levels for human and ecological receptors.

The objectives of the deeper multi-increment soil sampling (1-5 and 5-10 feet) were to:

- Obtain data on concentrations of COCs in soil, and
- Evaluate the risk of contaminants in soil leaching to groundwater that could migrate through the subsurface to the Willamette River.

AMEC conducted additional site characterization studies, including additional MIS sampling, as part of a *Data Gaps Investigation* in 2009 and 2010 (AMEC Geomatrix, 2010b). The purpose of the *Data Gaps Investigation* was to refine the understanding of the nature and extent of contamination with regard to:

- MIS Areas 2A, 3B, 6D, and RS-1, which were further subdivided and sampled based on the 2006 investigation (Figure 3);
- Discrete hot spots outside the areas of the further MIS investigations that may require removal action; and
- Groundwater downgradient of areas where elevated concentrations of COCs are present in soil.

Constituents and constituent classes detected in hotspots and in MIS samples within each sampling area are illustrated on Figure 5 and Figure 6, respectively.

During both the 2006 and the 2009/2010 MIS investigations, supplemental discrete soil/waste samples were also collected at the discretion of AMEC where visible contamination or waste material was observed. Any MIS sample with visible contamination was excluded from the MIS composite samples, and was instead analyzed separately as a discrete waste sample. Analytical results for these samples were used to identify additional potential hot spot source areas beyond those previously identified in the 2005 ROD. These potential hot spot areas are shown on Figure 5 and discussed in greater detail in Section 2.6.2 below.

Relevant data from investigations conducted at the site, including historical investigations, the AMEC E&E (2006) MIS investigation, and the AMEC Geomatrix (2010) Data Gaps Investigation, are presented in this document in support of the EE/CA removal action objectives and options. Results are summarized in Section 2.6.1, which describes the nature and extent of contamination at the site.

2.5 PREVIOUS CLEANUP ACTIVITIES

Cleanup activities have been implemented at the site in the past. In 1984, soil contaminated with PCBs was excavated from a location near North Bluff Street on the southeast edge of the site. A soil removal plan was approved by DEQ in December 1987, but no file information supports whether any cleanup ensued (DEQ, 2011). RCRA Closure certifications were accepted by DEQ on January 31, 1989. In March 1993, EMCON supervised the removal of two 8,000-gallon gasoline USTs from Area 2B and one 10,000-gallon diesel UST from Area 5A (EMCON, 1995). According to DEQ, additional cleanup activities completed at the site prior to UP's ownership include removal of waste storage tanks, waste drums, and some sandblast grit and miscellaneous debris from the site (supervised by EMCON); removal of petroleum USTs from the Sakrete area of the site by Hahn & Associates; and backfilling of a sludge pond near the former Sakrete facility (DEQ, 2011).

In addition, as part of the BFPPA with EPA, UP implemented aboveground cleanup of the site in 2009. Cleanup included the following activities:

- Demolition of remaining buildings at the site;
- Removal of asbestos, lead-based paint, and PCB-containing light ballasts from these structures;
- Removal of remaining concrete building pads and foundations;
- Removal of an old aboveground oil storage tank and contaminated surface soil; and
- Removal of junk, trash, and weeds from the site.

Waste generated during 2009 demolition and cleanup activities was managed according to applicable standards and requirements. Recycling of the waste was maximized to the extent possible. General demolition wastes, including concrete, wood, and metal building materials, were sorted on site following building demolition. Metal building materials and debris (including concrete reinforcements) were transported off site to Bob's Metals and/or Greenway Recycling (both in Portland, Oregon) for recycling. Concrete rubble was crushed and stockpiled on site for possible future use as fill or grading material. Oil recovered from the cleanout of the former aboveground oil storage tank on site was transported to Thermo Fluids, Inc., in Portland, Oregon, for recycling. Other wastes generated during the storage tank cleanout and removal (including oil-stained concrete from the associated concrete containment area) were disposed of at Hillsboro Landfill in Hillsboro, Oregon. Additionally, treated wood pilings, demolition debris containing lead-based paint, and asbestos waste from the site were also disposed of at Hillsboro Landfill. PCB-containing light ballasts from the demolished structures were disposed of by Clean Harbors, Inc., in Clackamas, Oregon.

For security reasons, the site was also fenced as part of this action and lighting was installed. This work was completed consistent with a *Building Demolition Work Plan* (AMEC Geomatrix, 2009). A summary report documenting this activity was submitted to EPA in February 2010 (AMEC Geomatrix, 2010a).

2.6 Source, Nature, and Extent of Contamination

This section describes the nature and extent of contamination remaining at the site based on the available analytical data from previous investigations, as described in Section 2.4. This section describes potential contamination at the site in three different contexts:

1. MIS Areas, broad areas of the site containing concentrations of COCs in soil that are relatively low but that potentially exceed risk-based action levels;
2. Discrete hot spots characterized independently from the MIS areas that may require removal action; and
3. Groundwater and the potential for further groundwater contamination due to soil impacts.

A summary of the distribution of major classes of COCs are presented in Figure 5 for each potential hot spot and in Figure 6 for each MIS investigation area.

2.6.1 MIS Areas

As noted in Section 2.4, MIS investigations were conducted to characterize potential risks arising due to widespread impacts of COCs at low levels identified in earlier studies. For the purposes of the MIS investigations, the site was subdivided into investigation units (subareas) based on information from previous investigations, site history, and anticipated contaminants (Figure 3). Analytical results from the various MIS investigations conducted at the site are presented in Tables 1 and 2. MIS investigations were conducted in 2006 and in 2009/2010 to further evaluate the nature and extent of widespread COCs present at the site. The COCs detected in the MIS areas typically have relatively low mobility in the environment compared to other pollutants.

In planning the MIS investigation, EPA recognized that the area of the site along the Willamette River shoreline presented a potential for migration of COCs directly into the river via stormwater runoff, wind erosion, and/or river bank erosion. For this reason, the river shoreline was further divided into units that extend from the edge of the river high water mark up the bank for a distance of approximately 50 to 100 feet. These units were assigned the identifier RS for river shoreline, followed by a sequential number (Areas RS-1, RS-2, and RS-3). The rest of the site was not considered to present an immediate risk for transport of contaminants to the river and are therefore referred to in this report as the Uplands Areas.

Results in this section are discussed separately for MIS areas in the Uplands Areas versus the river shoreline (RS) areas. These categories of areas are considered separately throughout this EE/CA because they represent different anticipated receptors and different potential exposure pathways/scenarios. RS areas pose a higher risk of COC migration directly to the river and river sediments, potentially exposing ecological and human receptors. Different action levels based on different potential exposure scenarios therefore apply to the RS areas (see Section 3.3).

2.6.1.1 MIS Quality Assurance Sampling

For quality assurance (QA) purposes, the 2009/2010 MIS investigation included collection of a triplicate sample in one of the MIS areas. Area 2A1 was chosen as the location for collection of the triplicate sample, because this area presented the greatest likelihood for the presence of most or all of the COCs. The triplicate sample was collected from the 0-1 foot depth interval in Area 2A1. The triplicate composite MIS sample was collected using a sampling grid with a different random starting location than the primary and duplicate samples within this MIS unit. The triplicate sample was analyzed for lead, PAHs, PCBs, and several additional metals.

The data quality review for the 2009/2010 MIS investigation revealed that the relative standard deviations (RSDs) showed that the compositing procedure resulted in precise analytical results, except for analyses of several PAHs. The higher RSDs for these select PAH compounds may be attributed to the fact that PAH results from the primary, duplicate, and triplicate samples were reported from varying dilutions, as those results reported from analyses using the same dilution agreed well with each other. The RSD could not be calculated for several PAHs where at least two of the three results were less than 5 times the method reporting limit (MRL). Analyses for metals and PCBs, for which the primary, duplicate, and triplicate were all reported from an undiluted analysis, provide a more representative measure of RSD. All of the RSDs for these results were less than the project-specific control limit of 30 percent. Based on this information, it appears that the triplicate sampling procedures in Area 2A1 generally yielded precise results, and it is therefore assumed that the same would be true for other MIS units in which triplicate sampling was not performed.

2.6.1.2 MIS Results for Uplands Areas

Uplands areas of the site include Areas 1A, 1B, 1C, 2A, 2A1, 2B, 3A, 3B (subdivided into subareas 3B1, 3B2, 3B3, and 3B4 for assessment of PCBs), 4, 5A, 5B, 6A, 6B, 6C, and 6D (subdivided into subareas 6D1, 6D2, and 6D3 for assessment of tetrachlorodibenzo-p-dioxins [TCDDs or dioxins]). Analytical results for these areas are presented in Table 1. Major classes of COCs detected within each sampling area are summarized on Figure 5.

Based on past site investigation results and the 2009/2010 sampling effort (AMEC Geomatrix, 2010b), the following COCs or classes of COCs were detected in MIS uplands areas: hydrocarbons (diesel and heavy-oil range), PCBs (Aroclor 1248, 1254, and 1260), tributyltin, metals (arsenic, cadmium, chromium, copper, lead, nickel, zinc), PAHs [acenaphthene, acenaphthylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene], cPAHs [pentachlorophenol, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, and naphthalene], and dioxins. The RI and FS reports (MFA, 2002a, 2004b) found that many of these constituents tended to be widely dispersed across the site at concentrations that were highly variable outside a few isolated source areas (hot spots) and generally characterized the concentrations as "low." As part of the BFPPA process, EPA determined that the MIS protocol was the best approach for sampling these areas to evaluate risks to human health and the environment posed by COCs that are widely dispersed and not linked to an identifiable source area.

Constituents detected in the MIS results for upland areas were distributed as follows (Table 1).

- Hydrocarbons, including diesel range and motor oil range hydrocarbons, have been detected via MIS at low concentrations in all the upland MIS areas, to depths of up to 10 feet and to a maximum concentration of 340 milligrams per kilogram (mg/kg) diesel (Area 6A) and 470 mg/kg motor oil (Area 6C).
- PCBs have been detected via MIS in Areas 1C, 2A, 2A1, 2B, 3A, 3B (including subareas 3B1, 3B2, and 3B3), 5B, 6A, 6B, 6C, and 6D. Most areas contain PCBs at relatively low concentrations, with the highest concentrations in Area 3B. In Area 3B, the maximum concentration of total PCBs was measured at 643.9 micrograms per kilogram (µg/kg) in 2006, with values up to 360 µg/kg measured during additional sampling in 2009/2010. PCBs were not detected in samples deeper than the 0-1 foot sample except in Area 2A1 (to a maximum depth of 14 feet) and 6C (to a maximum depth of 5 feet). Concentrations of PCBs at these depths were 25 µg/kg or less.
- Tributyltin has been detected only in Area 6A at a concentration of 81 µg/kg.
- Metals have been detected in samples from all upland areas. Maximum detected concentrations of each metal are as follows: arsenic, 7.8 mg/kg in Area 2B; cadmium,

0.6 mg/kg in Area 2A; chromium, 28 mg/kg in Area 6C; copper, 86.5 mg/kg in Area 6C; lead, 201 mg/kg in Area 6A; nickel, 32.5 mg/kg in Area 1C, and zinc, 330 mg/kg in Area 6C.

- PAHs have been detected in samples from all upland areas except 1A and 3A. No cPAHs have been detected in Areas 4 and 5A. Most MIS samples contain concentrations of cPAH and other PAH compounds lower than 500 µg/kg and typically lower than 100 µg/kg. The highest concentrations of these compounds were detected in samples from the following upland areas.
  - **Area 1B:** The highest concentrations of PAHs in any upland MIS sample were detected in Area 1B. The cPAHs detected include benzo(a)pyrene (up to an estimated 2,100 µg/kg), benzo(a)anthracene (up to an estimated 2,100 µg/kg), benzo(b)flouranthene (up to an estimated1,600 µg/kg), and indeno(1,2,3-cd)pyrene (up to an estimated at 640 µg/kg). The highest concentrations were generally found in the sample from the depth range of 1-5 feet. Most non-carcinogenic PAH compounds analyzed have been detected in MIS samples from Area 1B, with maximum detected concentrations above 500 µg/kg and up to 11,000 µg/kg (phenanthrene in the sample for depth range 1-5 feet). Concentrations of PAHs were also elevated, though at lower concentrations, in the samples for 0-1 foot and 5-10 feet.
  - **Area 2A:** The cPAH compound benzo(a)pyrene (560 µg/kg) was identified at elevated concentrations in the 0-1 foot sample interval. Concentrations of selected PAHs above 1,000 µg/kg have also been detected in shallow samples from Area 2A.
  - **Area 6A:** The cPAH compounds benzo(a)pyrene (710 µg/kg), benzo(a)anthracene (870 µg/kg), benzo(b)fluoroanthene (590 µg/kg), and others were detected at elevated concentrations in the 0-1 foot sample interval. Concentrations above 1,000 µg/kg have also been detected in shallow samples from Area 6A for other select PAH compounds, including flouranthene and pyrene.
- **Dioxins** have been detected in samples from Areas 4, 5A, 5B, 6B, 6C, and 6D (including subareas 6D1, 6D2 and 6D3). Concentrations of dioxins were generally below 10 picograms per gram (pg/g), except in shallow samples (0–1 foot) from Area 6D. Area 6D is located on the western edge of the site and borders the McCormick & Baxter CERCLA site that is a known source of dioxins. Area 6D was subdivided into three subareas (6D1, 6D2, and 6D3) during the MIS investigation in 2009/2010 for further assessment of dioxins. The maximum detected concentration of dioxins was measured at 49.8 pg/g in the shallow (0-1 foot) MIS sample from subarea 6D1.

One upland area (6A) was found to contain detectable concentrations of all six constituent groups. Otherwise, a maximum of five constituent groups was detected in any MIS upland area (Areas 6B, 6C and 6D). The lowest number of constituent groups detected in any MIS area was two (Area 1A).

2.6.1.3 MIS Results for River Shoreline Areas

This section describes conditions in areas located directly adjacent to the river referred to as the river shoreline areas or RS areas. This discussion includes results from the most recent MIS sampling work conducted in 2009/2010 (AMEC Geomatrix, 2010b). As shown on Figure 3, river shoreline areas of the site include Areas RS-1 (further subdivided into Areas RS-1a, RS-1b, RS-1c, and RS-1d for assessment of dioxins), RS-2, and RS-3. Contaminated soils in these areas present a greater potential for migration of COCs into the Willamette River and to contaminate sediments due to their proximity to the river and to impact ecological receptors. Table 2 summarizes the analytical data discussed in this section.

Based on historical results and the 2010 Data Gaps sampling effort (AMEC Geomatrix, 2010b), samples from areas adjacent to the river contained detectable concentrations of the following compounds and constituent groups: diesel range hydrocarbons, heavy-oil range hydrocarbons, PCBs, tributyltin, metals (arsenic, cadmium, chromium, copper, lead, nickel, zinc), PAHs, and dioxins. Constituents detected in areas abutting the river were distributed as follows (Table 2).

- **Hydrocarbons**, including diesel range and motor oil range hydrocarbons, have been detected in MIS samples from all RS areas, to depths of up to 10 feet. The maximum concentrations were 91 mg/kg diesel and 370 mg/kg motor oil in Area RS-1.
- **PCBs** have been detected via MIS in all three areas, with detected concentrations of total PCBs ranging from 28 to 192 µg/kg. The maximum concentration of total PCBs was 192 µg/kg in the 0-1 foot sample from Area RS-2. The only detections of PCBs below the 0-1 foot interval were measured in samples from Area RS-1, where the 1-5 foot and 5-10 foot samples contained concentrations of PCBs of 68 and 69 mg/kg, respectively.
- **Tributyltin** has been detected in Areas RS-1 and RS-2 to depths up to 10 feet. All detected concentrations were below 15 µg/kg, except in the 5-10 foot sample from Area RS-2, which contained the maximum concentration of tributyltin among all MIS samples adjacent to the river at 26 µg/kg. In both areas, the highest concentration of tributyltin was detected in the 5-10 foot interval.
- **Metals** have been detected in MIS samples from all areas adjacent to the river. The maximum detected concentrations of each metal are as follows: arsenic, 3.8 mg/kg in Area RS-1; cadmium, 0.3 mg/kg in Area RS-2; chromium, 15 mg/kg in Area RS-1 and Area RS-2; copper, 71.3 mg/kg in Area RS-1; lead, 37 mg/kg in Area RS-3; nickel, 24.2 mg/kg in Area RS-1, and zinc, 107 mg/kg in Area RS-1.
- **PAHs** have been detected in MIS samples from all areas adjacent to the river. The MIS samples from Area RS-1 contained the highest detected concentrations of these compounds, including the cPAHs benzo(a)anthracene (460 µg/kg), benzo(a)pyrene (520 µg/kg), indeno(1,2,3-cd)pyrene (210 µg/kg), and others. Concentrations of cPAHs increased with depth. In MIS samples from Areas RS-2 and RS-3, no PAH compound was detected at a concentration above 120 µg/kg, with most concentrations well below 100 µg/kg.
- **Dioxins** have been detected in MIS samples from all areas adjacent to the river. The highest concentrations of dioxins were detected in Area RS-1, which was subdivided into four subareas (RS-1A, RS-1B, RS-1C, and RS-1D) during the MIS investigation in 2009/2010 to further assess the nature and extent of dioxins. The maximum detected

concentration of dioxins was 29.6 pg/g in the 0-1 foot MIS sample from subarea RS-1D. Concentrations of dioxins generally decline with depth.

MIS samples from Areas RS-1 and RS-2 were found to contain detectable concentrations of all six constituent groups. Five constituent groups were detected in Area RS-3.

2.6.2 "Hot Spot" Potential Removal Action Areas

Within the MIS areas, 34 smaller areas have been identified for potential removal action due to elevated concentrations of COCs detected by discrete sampling or based on visible evidence of potential contamination observed during demolition activities (Figure 5; Tables 3–5). Six areas were identified in the DEQ's 2005 ROD as hotspot areas planned for excavation. Seventeen areas were identified in the DEQ ROD as hotspot areas planned for capping. An additional 11 potential hotspot areas were identified and characterized as part of the UP CERCLA Removal Action investigations. In order to evaluate the nature and extent of hot spots, analytical results for discrete samples collected during historical investigations were reviewed. Discrete "waste" samples were collected during the 2006 and 2010 MIS investigations, as described in Section 2.4, in order to further characterize the nature and extent of the potential hot spots. The general locations of these hot spot areas are shown on Figure 5. Analytical results for these potential hot spot areas are presented in Tables 3–5 and further described in the following subsections.

2.6.2.1 Hot Spots Identified in the 2005 DEQ ROD

The 2005 ROD identified six hot spot areas for excavation and removal of the affected soil. The locations of these areas are shown on Figure 5. These areas are deemed to require active response based on the ROD that requires excavation of each of these areas.

- **Area A2-1:** Area A2-1 was proposed for excavation in the DEQ ROD based on elevated concentrations of diesel, motor oil, and PAHs, identified during historical investigations (Table 3). This localized hot spot is located largely within Area 2B, but extends slightly into Area 2A (Figure 5). A soil sample collected at a depth of 1.3 feet below ground surface in Area A2-1 showed a diesel concentration of 26,000 mg/kg, compared to a commercial risk-based concentration (RBC) cleanup level of 23,000 mg/kg. The originally proposed excavation Area A2-1 was revised to encompass the area of former sample location WS-2A-16 (Area 2A), where diesel and motor oil were detected at concentrations above residential RBCs, but below the commercial RBCs. The eastward extent of the excavation area was established during the 2009/2010 data gaps investigation that revealed no elevated concentrations of diesel/heavy oil at location RC-4 (AMEC Geomatrix, 2010b). The estimated extent of potential excavation at Area A2-1 is approximately 2,400 square feet from the contaminated surface to an average depth of 7 feet below ground surface.

- **Area A2-3:** Area A2-3 is an isolated lead hot spot within Area 2B (Figure 5). Samples from 1996 showed lead concentrations as high as 4,260 mg/kg (Table 3). The estimated extent of potential excavation for Area A2-3 is approximately 706 square feet of surface area excavated to a depth of 4 to 6 feet.

- **Area A5-11:** Area A5-11 is located within Area 5A (Figure 5). Elevated concentrations of PAHs, including benzo(a)pyrene at concentrations as high as 610,000 µg/kg, are present at depths of 5 feet and 8 feet bgs (Table 3). Selected PAH compounds are also present at elevated concentrations as deep as 11.5 feet, though the concentrations are several orders of magnitude lower at this depth than those seen at shallower depths. Nevertheless, concentrations of PAHs in these deeper soils are still in some cases more than an order of magnitude greater than the Oregon cleanup level. Based on these findings, the hot spot represented by Area A5-11 is estimated to be approximately 1,100 square feet in area and 12-14 feet deep. Area A5-11 has been extended to the south from its original boundary described in the DEQ ROD, because results from RC-5, collected in 2009, indicate that contamination extends at least as far as sample location RC-5 (AMEC Geomatrix, 2010b).

- **Area A5-12A/B:** Area A5-12A/B (Figure 5) contains elevated concentrations of PCBs, diesel, and arsenic. This potential excavation area is located within 50 feet of the river in Area 5A, but extends into Area RS-2 and a small portion of Area 5B. Samples collected at a depth of 0.5 foot showed total PCB concentrations of up to 1,300 µg/kg, which is above both the Joint Source Control Strategy (JSCS) screening level values (SLVs) (EPA/DEQ, 2007) and EPA Regional Screening Levels (RSLs) (EPA, 2011a) (Table 3). The area of elevated PCB concentrations is estimated to be approximately 6,500 square feet and 1 to 2 feet deep. In this area, arsenic was also found at elevated concentrations in deep samples (depths of 12 and 14 feet bgs); however the actionable level identified in the DEQ ROD for arsenic is 160 mg/kg. Therefore the depth of removal was established based on the PCB concentrations.

- **Area A5-13**: Area A5-13 (located in Area RS-2; Figure 5) was proposed for excavation by DEQ in the ROD based on elevated PCB concentrations (Table 3). Samples collected at 0.5 feet bgs contained elevated concentrations of PCBs (total PCBs at a concentration of up to 2,400 µg/kg, compared to a JSCS SLV of 0.39 µg/kg). Samples collected at and below 2 feet of depth in this subarea did not contain detectable concentrations of PCBs. This potential excavation area is estimated to be approximately 500 square feet in area and 1 foot to 2 feet deep, based on results from discrete samples.

- **Area A4-5:** Area A4-5 is located in Area RS-3 (Figure 5). Analytical results showed a PCB concentration of 5,020 µg/kg for the sample collected at a depth of 5 feet at GP-73, which is well above the JSCS SLV, and low-level PAHs in the samples collected at a depth of 4 feet at GP-149 and 6 feet at DP-A4-17 (Table 3). The PAHs were deemed a concern due to this area's proximity to the river.

2.6.2.2 Defining Additional Hotspots

Oregon Administrative Rules (OAR) 340-122-0115 define *hot spots of contamination*:

> For media other than groundwater or surface water, (e.g., contaminated soil, debris, sediments, and sludges; drummed wastes; "pools" of dense, non-aqueous phase liquids submerged beneath groundwater or in fractured bedrock; and non-aqueous phase liquids floating on groundwater), if hazardous substances present a risk to human health or the environment exceeding the acceptable risk level, the extent to which the hazardous substances: (A) Are present in concentrations exceeding risk-based concentrations

corresponding to: (i) 100 times the acceptable risk level for human exposure to each individual carcinogen; (ii) 10 times the acceptable risk level for human exposure to each individual noncarcinogen; or (iii) 10 times the acceptable risk level for exposure of individual ecological receptors or populations of ecological receptors to each individual hazardous substance.
(B) Are reasonably likely to migrate to such an extent that the conditions specified in subsection (a) or paragraphs (b)(A) or (b)(C) would be created; or (C) Are not reliably containable, as determined in the feasibility study." OAR 340-122-0115

Hot spots were identified by DEQ and in the RI/FS based on the presence of COCs at concentrations significantly elevated compared to other areas on site. Samples from each potential hot spot generally contain COCs at concentrations at least an order of magnitude higher than the maximum concentrations of those COCs in MIS samples. The six hot spots identified in the 2005 ROD were evaluated as part of the removal action process under EPA, and the boundaries were extended if warranted by observed concentrations of COCs. Areas were also identified as potential removal action areas if significant staining or other evidence of contaminated material was observed. During the 2006 and 2010 MIS investigations, if samples were found that contained visual evidence of contamination, these samples were not included in the composited MIS samples. Instead a discrete sample was collected for analysis, and the results were evaluated to assess if a potential removal action was warranted for the area.

COCs vary from hot spot to hot spot and include mostly petroleum products, but also include PCBs, PAHs/cPAHs, dioxins, and metals. The hot spot areas generally represent the most impacted areas on the site and therefore present the highest risk to the environment. Some of these areas represent greater risk based upon the magnitude of COC concentrations, the mobility of the COC, location near the river bank, and/or the depth of the impacts (proximity to the surface representing a greater risk).

2.6.2.3 Potential Hotspot Areas Not Identified in the ROD

Potential hot spot areas are deemed to require active response actions if they meet the Oregon definition of a hot spot. If they do not, the areas are considered as part of the larger MIS areas they fall within and which were evaluated using the MIS methods and stream-lined risk evaluation. Summarized below is the status of the 11 additional potential hot spots not identified in the ROD:

- **Former Smokestack Area**: A potential hot spot was identified at the location of the former smokestack in Area 2A, where black ashlike material was discovered during demolition of the building in July 2009. The ashlike material was characterized and disposed of following sampling and laboratory analysis, but belowgrade excavation was not conducted (AMEC Geomatrix, 2010a). Several metals were detected in the sample, including beryllium at a concentration of 1.0 mg/kg, chromium at 25 mg/kg, copper at 59.2 mg/kg, lead at 75 mg/kg, mercury at 0.15 mg/kg, nickel at 53 mg/kg, and zinc at 153 mg/kg. These concentrations do not fit the Oregon state definition of a hot spot as they are not greater than 10 times the screening levels. The location where the ashlike material was found is shown on Figure 5. Since the concentrations of COCs in this area are also below actionable levels for the uplands, no further action is required of this area.

- **Area WS-3A-2A**: Diesel was detected at a concentration of 4,800 mg/kg in waste sample WS-3A-2A (located in Area 3A) collected in 2006 at the depth range of 9-10 feet (Figure 5; Table 4). Results for nearby sample GP-139, similarly showed diesel present at depth and not in shallow soils. All concentrations in both samples are below the commercial RBCs, although the concentration of diesel in the waste sample was slightly greater than the residential screening level. This area, therefore, is not considered a hotspot. Because MIS Area 3A does not exceed calculated residential risk criteria, but waste sample WS-3A-2A exceeded residential screening levels, a risk evaluation was conducted consistent with the methods described in more detail in Section 2.7 for Area WS-3A-2A to determine whether the area exceeds the residential risk threshold (Table 6). The results of the evaluation indicate that at depth (9-10 feet), Area WS-3A-2A exceeds uplands actionable levels, specifically a total residential risk of 1E-5, as well as an individual COC risk of 1E-6 for diesel and benzo(a)pyrene. Although WS-3A-2a is not a hot spot, this area is actionable.

- **Stained Soil under Slab**: Stained soil was observed in Area 5A in 2009 following removal of a concrete slab incidental to the data gaps study. The area of observed stained soil measured approximately 15 to 20 feet in diameter. The location of the stained soil is shown in Figure 5. This area was identified as a hotspot for removal action based on the uncertainty of actual COC concentrations. Since this area is still considered a hot spot, excavation is assumed.

- **Area WS-6A-23**: Diesel at 3,600 mg/kg was detected in waste sample WS-6A-23 (located in Area 6A) in the depth range of 3 to 4 feet (Table 4). This concentration is below the DEQ commercial RBC screening level of 23,000 mg/kg and the residential RBC screening level of 3,900 mg/kg. Due to the low-level concentrations, this area is not considered a hot spot, and because concentrations are below the RBC screening levels, the area is not considered actionable. As a result no action is required to address this area.

- **Area WS-6A-8/9**: Waste samples WS-6A-8B, -8C, and -9A (located in Area 6A) showed elevated for diesel, motor oil, and selected PAH compounds over an area of approximately 1,600 square feet to a depth of 8 to 9 feet. All concentrations of COCs were well below the threshold level of 10 times commercial RBCs and industrial RSLs, except for the PAH compound benzo(a)pyrene, detected at a concentration of 1,400 µg/kg compared to an EPA industrial RSL of 210 µg/kg (6 times the RSL). Concentrations of several PAH compounds also exceed residential RSLs and RBCs. This area does not, however, meet the criteria of a hot spot area. This area will be included with Area 6A (which also exceeds industrial risk levels) in the evaluation of removal alternatives, and will be evaluated for the range of removal action options including capping, institutional controls, and excavation.

- **Area A6-14B**: Area A6-14B (located in Area 6C and Area RS-1; Figure 5) was originally identified as having concentrations of PAHs and PCBs above RBCs and RSLs. This subarea also extends into Areas RS-1d and RS-1c. Construction by EPA contractors in 2005 of a ramp to the Willamette River appears to have resulted in the removal of most, if not all, of the contaminated soil in the area of the ramp. Samples collected from the area of the former ramp by AMEC E&E in 2005 did not contain concentrations of PCBs above detection, or of PAHs above RBCs, RSLs, or JSCS SLVs (AMEC E&E, 2006c). Based on the current data, this area does not meet the criteria of a hot spot, and a removal action is therefore not required in this area.

- **Area WS-6D-8**: Discrete waste soil sample WS-6D-8, collected in Area 6D2 at a depth of 2 to 2.5 feet (Figure 5), contained concentrations of motor oil above the DEQ commercial RBC and diesel above the residential RBC (Table 4). The maximum concentration of motor oil of 24,000 mg/kg exceeds the DEQ commercial RBC screening level of 23,000 mg/kg by substantially less than an order of magnitude. Due to the relatively low exceedance, this area is not considered a hot spot based on the Oregon criteria. The calculated occupational/industrial risk for MIS Area 6D2 does not exceed the acceptable risk threshold, but concentrations of COCs in potential hot spot WS-6D-8 slightly exceed occupational/industrial screening levels. Therefore, a risk evaluation was conducted for Area WS-6D-8 to assess whether that area exceeds the occupational risk threshold (Table 6). The results of the evaluation indicate that potential hot spot WS-6D-8 does not exceed a total occupational risk of 1E-5, a HI of 1, or an individual COC risk of 1E-6. As in surrounding Area 6D2, the calculated risk for potential hot spot WS-6D-8 does not exceed the occupational risk threshold, but exceeds the residential risk threshold. Area WS-6D-8 will therefore be included as part of Area 6D2 in the evaluation of removal action options.

- **Area WS-6D-13/14**: Area WS-6D-13/14 is located in the vicinity of waste samples WS-6D-13A, -13B, and -14B in Area 6D (Figure 5). These samples showed concentrations of benzo[a]pyrene above the Oregon commercial RBC and EPA industrial RSL in an area of approximately 1,900 square feet at a depth of 4 to 5 feet. No constituent was detected in these soils at concentrations greater than 10 times the commercial RBCs or industrial RSLs. This area is located in Area 6D. This area does not meet the criteria of a hot spot, and it will therefore be included as part of Area 6D1 (which is in exceedance for industrial risk) in the evaluation of removal action options.

- **Area WS-RS-1-24**: Waste sample WS-RS-1-24 (located in Areas RS-1a and RS-1b; Figure 5) contained concentrations of the PAH compounds indeno(1,2,3-cd)pyrene (150 µg/kg) above the JSCS SLV of 100 µg/kg, and benzo[a]pyrene (280 µg/kg) above the industrial RSL of 210 µg/kg (Table 5; Figure 7. Based on the relatively low concentrations identified, this area is not considered a hot spot but will be included as part of Areas RS-1a and RS-1B in the evaluation of removal action options.

- **Area A4-8:** Analytical results for hot spot A4-8 (Figure 7; Table 5) showed low-level PAHs, mostly below JSCS SLVs. This potential hot spot area, located in Area RS-3, is estimated to be approximately 650 square feet in area, and most constituents with elevated concentrations are present at depth only, at approximately 5 to 14 feet bgs. Based on the relatively low concentrations identified, this area is not considered a hot spot but will be included as part of the evaluation of Area RS-3.

- **Area WS-RS-3-1:** Arsenic and lead were detected above Oregon commercial RBCs and EPA industrial RSLs in waste sample WS-RS-3-1, collected at a depth of 5 to 8 feet in Area RS-3 (Figure 5). Neither arsenic nor lead was detected at a concentration greater than 10 times the commercial RBCs or EPA industrial RSLs (Table 5). Area WS-RS-3-1 is not therefore considered a hot spot and will be included with Area RS-3 in the evaluation of removal action options.

In short the stained soil under the slab in Area 5A is the only additional identified location found to fit the definition of a *hot spot* based on occupational/industrial RSLs and RBCs, using the Oregon state definition (an area with concentrations of COCs 10 times greater than screening levels for non-carcinogens and 100 times greater than screening levels for carcinogens, or having COCs that are likely to be mobile). Specifically this stained soil area must be removed. In addition, Area WS-3A-2A was found to exceed uplands actionable levels based on residential exposure, and will therefore require a removal action. The remaining potential hot spot areas have concentrations of constituents similar to the surrounding MIS area, and will therefore be considered for removal actions as part of the MIS area where they are located.

2.6.3 Groundwater

Groundwater sampling has been conducted during different stages of the site investigation at both monitoring wells and direct-push borings, as summarized in Table 7, and results are compared to various screening levels. Groundwater sampling locations and relevant data above screening levels are shown in Figure 7. Constituents detected in groundwater at the site include PAHs, TPH (gasoline, diesel, and motor oil range), and metals (antimony, arsenic, beryllium, chromium, copper, lead, nickel, and zinc). Selected VOC compounds were also detected sporadically in groundwater samples, but no VOCs were detected consistently in groundwater samples from wells on site. The most recently collected groundwater samples (2009) support findings from earlier investigations that showed low-level concentrations of COCs in the shallow groundwater slightly above screening levels for select constituents, including metals, PAHs, and TPH.

Under the DEQ PPA with Triangle Park LLC, Triangle Park LLC was not liable for groundwater under state law. Groundwater is evaluated in this section in order to establish current groundwater conditions, particularly to establish whether soil on site is likely to impact groundwater in the future and whether monitoring of groundwater is necessary. The 2005 DEQ ROD indicates that if any new discovery of soil contamination is made which may have a significant impact on groundwater, the DEQ will re-evaluate the selected remedy to determine whether it continues to meet criteria for site cleanup, but no groundwater response actions were found necessary.

The groundwater COC most consistently observed at the site at concentrations above screening levels is TPH, predominantly TPH-D and TPH-O. TPH-D has been measured at concentrations up to 26,000 µg/L, and TPH-O has been measured at concentrations up to 9,940 µg/L, compared to the screening level for both constituents of 90 µg/L. Elevated concentrations of TPH do not necessarily appear to be directly adjacent to hot spots identified on site.

Concentrations of metals are below screening levels in groundwater monitoring wells in all areas except in samples collected from MIS Areas 1A, 6A, 6B, 6D, and in samples taken from scattered direct push borings from MIS Area 4. Groundwater samples from wells MW-1 and MW-2 in Area 1A were found to contain the most elevated concentrations of metals on site during sampling in 1993 (Figure 7). For the most part, concentrations of metals from groundwater samples from wells near the river are below screening levels, except in Area 6, where numerous metals were measured above screening levels. However, groundwater samples where these concentrations were measured were collected from direct-push borings, influenced by excessive sample turbidity, thereby artificially inflating metals concentrations. These results are therefore not considered representative of the aquifer conditions.

Concentrations of cPAHs measured in groundwater during previous investigations on site are typically below detection, or, where detected, very low. Benzo(a)pyrene is considered an indicator cPAH and is typically present where cPAHs/PAHs are found at the site. Concentrations of benzo(a)pyrene have typically been lower than the maximum contaminant level (MCL) of 0.2 µg/kg in water samples collected at the site (Table 7). Elevated concentrations of cPAHs have been measured in only two samples: sample SB15-W [6 µg/kg benzo(a)pyrene], collected in 1993 in Area 2B, and sample SB1A-W-0923 [31 µg/kg benzo(a)pyrene], collected in 1993 in Area 5A (Figure 7). Sample SB15-W was collected in an area where an adjacent groundwater sample (RC-1) and downgradient sample (RC-3) collected in 2010 contained concentrations of cPAHs below the EPA RSL and mostly below the detection limit, suggesting no remaining impact is present in this area. Sample SB1A-W-0923 was collected immediately adjacent to and downgradient of hotspot A5-11, the hot spot with the highest measured concentrations of cPAHs at the site. These elevated concentrations of cPAHs are likely related directly to the hot spot and are expected to decline following excavation and removal of the highly affected soils.

Scattered detections of VOCs in groundwater at concentrations above the applicable screening levels have been documented during historic sampling. These VOCs include 1,1-dichlorethane, benzene, carbon disulfide, naphthalene, tetrachloroethene, and vinyl chloride. Most of these analytes were present above screening levels in single individual samples over the history of groundwater sampling on site and were not found to exceed screening levels in prior or following sampling events. 1,1-Dichlorethene was detected above screening levels in only two samples, and vinyl chloride in three samples over the many sampling events conducted. Analysis of groundwater quality and consideration of potential actions in the EE/CA focus primarily on potential future impacts to groundwater due to residual constituents in soil at the site.

DEQ's 2005 ROD concluded that although some impact to shallow groundwater is present on site, residual soil contamination remaining on site following soil cleanup is not expected to significantly impact groundwater in the future. This conclusion was based on evaluations of the potential for constituents present in soil to leach into groundwater conducted as part of historical investigations.

These investigations used a weight-of-evidence approach that considered depth of soil where COCs were detected, concentrations of COCs in soil, and observed concentrations of COCs in groundwater downgradient of known soil hot spots. These investigations also included assessment of the vertical distribution of constituents. Recent results from MIS sampling support earlier findings that show that most of the COCs that exist at the site are present in near-surface and shallow soils, with concentrations decreasing with depth. Typically, contaminant concentrations in soil decrease to low or nondetectable levels at depths above the water table (9-25 feet bgs) (AMEC Geomatrix, 2010b).

MFA (2004b) concluded that available data lent no support to the potential for leaching of COCs from soil to groundwater. That assessment was done by:

- Comparing concentrations of COCs in soil to screening levels using a dilution-attenuation factor of 20 to account for natural processes that lower contaminant concentrations in soil; and
- Comparing dissolved concentrations of COCs in groundwater to screening levels protective of aquatic life.

More recently, analytical results of MIS soil samples show that given a dilution factor of 20, only benzo(a)pyrene and dioxins are potential candidates to evaluate for potential future leaching into shallow groundwater. Both of these constituent groups have low solubility and a high affinity to adsorb to soil and are, therefore, unlikely to be mobile and reach surface water via groundwater transport (see Section 2.6.4).

In order to further assess risk to groundwater from soil, concentrations of constituents in MIS samples were compared to EPA soil screening levels (SSLs) protective of groundwater (Tables 1 and 2). Of the contaminants detected at the site, concentrations of the following compounds exceeded these screening levels in at least one MIS sample: Aroclor 1254, Aroclor 1260, arsenic, and all cPAHs for which SSLs are established. Exceedances of the SSLs for the PCB congeners were nominal, at much less than an order of magnitude, except in Area 3B, where Aroclor 1254 reached a maximum value of 150 μg/kg (the SSL of 8.8 μg/kg). Concentrations of Aroclor 1260 reached a maximum value of 490 μg/kg compared to the SSL of 8.8 μg/kg. Because the mobility of PCBs tends to be extremely low, it is unlikely that these compounds will contribute to groundwater contamination (see Section 2.6.4.2).

Arsenic exceeds natural background concentrations in only one MIS sample (7.8 μg/kg in the sample from 0 to 1 foot in MIS Area 2B compared to a natural background concentration of 7 μg/kg [see Section 2.7.4]). Arsenic in soil in the MIS areas is therefore unlikely to affect groundwater at the site.

Concentrations of cPAHs in MIS soil samples significantly exceed SSLs based on protection of groundwater. The maximum exceedance is of benzo(a)pyrene in Area 1B, at a concentration of 2,100 µg/kg compared to the SSL of 3.5 µg/kg. However, an empirical evaluation of groundwater indicates that these concentrations of cPAHs in MIS areas are unlikely to impact site groundwater. Concentrations of cPAHs measured in groundwater during previous investigations at the site are typically below detection, or, where detected, very low, with concentrations of benzo(a)pyrene typically lower than 0.2 µg/L (Table 7). Elevated concentrations of cPAHs have been measured in only two samples: sample SB15-W [6 µg/L benzo(a)pyrene], collected in 1993 in Area 2B, and sample SB1A-W-0923 [31 µg/L benzo(a)pyrene], collected in 1993 in Area 5A (Figure 7). Sample SB15-W was collected in an area where an adjacent groundwater sample (RC-3) collected in 2010 contained concentrations of cPAHs below detection, suggesting no remaining impact is present in this area. Sample SB1A-W-0923 was collected immediately adjacent to and downgradient of hot spot A5-11, the hot spot with the highest measured concentrations of cPAHs at the site. The elevated concentrations of cPAHs in this are likely related directly to the hot spot and are expected to decline following excavation and removal of the highly affected soils. Based on these considerations and the earlier risk analysis (MFA and EMS, 2004), cPAHs remaining in soils at the site following removal actions are not anticipated to impact groundwater.

Eight monitoring wells, MW-1 through MW-8, are located near the waterfront, as shown in Figure 3. These monitoring wells are available to monitor concentrations of constituents over time in groundwater that may flow into the Willamette River.

2.6.4 Physical and Chemical Attributes of COCs

The mobility and persistence of the COCs identified in soil and groundwater at the site are discussed in this section. These characteristics can be inferred from the physical properties of each compound.

2.6.4.1 Petroleum Hydrocarbons

Petroleum hydrocarbons are a complex mixture of hundreds of chemicals, each with individual fate and transport characteristics (Potter and Simmons, 1998). Gasoline, diesel, and motor-oil range hydrocarbons have been detected at the site. Gasoline-range petroleum hydrocarbons are typically fairly mobile within the environment, while diesel and motor oil range hydrocarbons are typically less mobile. Solubility and volatility of all compounds generally decrease with increased molecular weight, and the more volatile and water soluble compounds are lost most rapidly from source areas.

Degradation and biodegradation of petroleum hydrocarbons have been documented for numerous sites under a wide variety of geochemical conditions, indicating these processes are likely to occur at most sites (Wiedemeier et al., 1999). When a mixture of petroleum hydrocarbons is released into the environment, the composition changes with time due to natural attenuation processes often referred to as *weathering*. The type and degree of weathering depend on the initial composition of the petroleum mixture and on site-specific environmental conditions, because different types of hydrocarbons weather differently under different conditions. Petroleum compounds are also degraded readily in the subsurface by naturally occurring microbes under a wide variety of conditions. While petroleum compounds are typically degraded more quickly under aerobic conditions, anaerobic degradation can be equally effective at attenuating the concentrations of petroleum compounds. Because petroleum contains a complex and variable mixture of hydrocarbon compounds, all of which eventually break down to carbon dioxide and water, or to methane (depending on the degradation environment), the breakdown processes produce no telltale daughter products that can be used as evidence that petroleum biodegradation is occurring.

2.6.4.2 PCBs

PCBs, marketed under the name Aroclor until commercial production in the United States was stopped in 1977, are mixtures of different congeners of chlorinated biphenyl. The PCB compounds Aroclor 1242, 1254, and 1260 have been detected at the site. The relative importance of various environmental fate mechanisms generally depends on the degree of chlorination (HSDB, 2011). In general, the persistence of PCBs increases with an increase in the degree of chlorination. Mono-, di-, and trichlorinated biphenyls (Aroclor 1221 and 1232) biodegrade relatively rapidly; tetrachlorinated biphenyls (Aroclors 1016, 1242 and 1248) biodegrade slowly; and higher order chlorinated biphenyls (Aroclors 1254 and 1260) are resistant to biodegradation. Biodegradation of higher order chlorinated congeners may occur very slowly due to natural environmental processes, but no other degradation mechanisms have been shown to be important in natural water and soil systems. If released to soil, PCBs adsorb strongly to soil particles with adsorption generally increasing with the degree of chlorination of the PCB congener.

2.6.4.3 Tributyltin

Compounds containing tributyltin are typically used as pest control products, often on wood as part of paint formulations, and may be released to the environment from anthropogenic sources (United Nations Environment Programme, 2006). Tributyltin compounds include tributyltin oxide, tributyltin benzoate, tributyltin chloride, tributyltin fluoride, tributyltin linoleate, tributyltin methacrylate, and tributyltin naphthenate. Tributyltin was detected in soil samples collected at the site. When released to soil, tributyltin is expected to bind strongly to soil and be immobile (HSDB, 2011). Tributyltin is susceptible to biodegradation and is reported to have a half-life in soil of 15 to 20 weeks. Tributyltin on the soil surface may also slowly photodegrade but will not volatilize from near-surface soil.

2.6.4.4 Metals

Metals are found naturally in the environment at varying concentrations and may also be introduced to the environment via anthropogenic releases. Arsenic, cadmium, chromium, copper, lead, nickel, and zinc have been detected in soils at the site.

A number of physical, chemical, and biological processes influence the concentrations of metals in an aqueous system. These processes include chemical speciation, hydrolysis, volatilization, sorption, bioaccumulation, and biodegradation. The mobility of each metal in soil and groundwater is dependent upon a number of factors, including soil organic matter content and geochemical conditions, such as pH and redox conditions. Each metal behaves differently in a particular environment due to its unique chemical nature. Evaluation of the mobility of metals is especially difficult given their ability to form ions and interact with water, minerals, biota, and organic materials.

2.6.4.5 PAHs and cPAHs

PAHs occur in the environment both naturally and as a result of anthropogenic releases, including releases of petroleum products and as by-products of partial combustion (HSDB, 2011). A number of PAH compounds, including acenaphthene, acenaphthylene, anthracene, benzo(g,h,i)perylene, flouranthene, flourene, phenanthrene, and pyrene, and carcinogenic PAHs (cPAHs), including pentachlorophenol, benzo(a)pyrene, benzo(b)flouranthene, benzo(k)flouranthene, chrysene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, and naphthalene, were detected at the site.

With the exception of naphthalene, PAHs are typically fairly immobile in the environment because of their low water solubilities, low volatilization potential, and strong tendencies to adsorb to soil. Biodegradation is the primary natural mechanism of reduction of PAH concentrations in soil. PAH half-lives on the order of 0.5-1 year are typically reported (HSDB, 2011). Naphthalene is similar to benzene in mobility and also readily biodegradable.

Biodegradation is likely to reduce PAH concentrations over time, and strong adsorption of PAH compounds to soil is likely to prevent leaching of PAHs to groundwater in the future. PAHs have not been detected consistently in groundwater at the site and are generally at low concentrations where detected except immediately downgradient of PAH/cPAH hotspots, confirming the limited groundwater impacts and the low mobility of these compounds.

2.6.4.6 Dioxins

Polychlorinated dibenzo-p-dioxins, often referred to as dioxins, occur as 75 different isomers, with 22 possible isomers of tetrachlorodibenzo-p-dioxin. The mixture of these 22 isomers is referred to as dioxins. Dioxins are found in emissions from combustion, including the incineration of wood and other wastes, and as a by-product of industrial processes (HSDB, 2011). Dioxins have been detected at the site.

Dioxins are expected to adsorb strongly to soils and sediment and be immobile (HSDB, 2011). Degradation and biodegradation processes are slow, with the half-life of dioxin isomers in subsurface soil ranging from 25 to 100 years.

2.7 STREAMLINED RISK EVALUATION

A streamlined risk evaluation (SRE) is part of the site characterization process. The SRE is based on a conceptual site model (CSM) for the site that is presented in this section. The CSM combines the hydrogeologic conceptual model for the site with an analysis of contaminant migration pathways and potential receptors. The scope of the SRE is between that of the limited risk evaluation conducted for emergency removals and that of the baseline risk assessment conducted for remedial actions.

The following guidance was used to complete the SRE.

- Guidance on Conducting Non-Time-Critical Removals Under CERCLA (EPA, 1993);
- Streamlined Site Characterization Approach for Early Actions and Impact on Risk Assessment Data Requirements (DOE, 1994);
- Non-Time-Critical Removal Risk Evaluation (EPA, 1997).

The SRE presented here focuses on existing or imminent threats to human health or the environment that the removal action is designed to address. This section describes the contaminant sources and exposure mechanisms at the site and then presents human health and ecological risk evaluations. This section evaluates the risk in light of those conditions. A more thorough discussion of the COCs present and their distribution is presented in Section 2.6.

2.7.1 Conceptual Site Model

The conceptual site model combines a hydrogeologic conceptual model with contaminant migration pathways and analysis of potential receptors. The CSM identifies human and environmental receptors based on land use and activities at and near the site, and characterizes the nature of their contact with impacted media at and near the site. If a receptor has the potential to contact impacted media, a potentially complete exposure pathway is considered to exist. Separate pathways are included in the CSM for human health and ecological receptors that may have complete pathways linked to these releases. A block diagram visually depicting the CSM is presented in Figure 8. The block diagram illustrates the current understanding of the potential sources and releases of constituents, generalized hydrogeologic pathways, and constituent distribution and transport at the site.

The CSM shown in Figure 8 is based on assumed future land use as part of the University and its location bordering the Willamette River (see Section 2.3.2).

2.7.1.1 Sources

Releases of hazardous constituents have occurred at the site historically as a result of long-term industrial use of the site and the import of potentially impacted fill materials, primarily affecting shallow soils. The nature and distribution of these COCs is well characterized from previous investigations. Impacts have been observed in soil and groundwater, with soil generally impacted with widespread but low concentration of COCs. A number of hotspot areas have also been identified that represent historical source areas containing higher concentrations of COCs, particularly hydrocarbons and PAHs.

Constituents in soil could migrate through the unsaturated zone soils and into the underlying groundwater. However, potential migration of COCs from soil to groundwater is expected only in hot spots, where higher concentrations of constituents have been measured. Site characterization has shown that the majority of COCs present at the site are at concentrations too low to be likely to impact groundwater, or the COCs are relatively immobile in the subsurface (Section 2.6.4). With the exception of VOCs in a few of the hot spot areas, COCs on the site (metals, PCBs, dioxins, and PAHs) have very low mobility in the subsurface.

2.7.1.2 Transport and Exposure Mechanisms

Constituents in soil may leach into groundwater due to infiltration of precipitation into impacted soil. COCs in surface soil may also mobilize in fugitive dust in areas of the site that are not vegetated or capped (such as with a layer of clean soil, a building, or pavement). COCs in groundwater may have the potential to migrate to surface water (the Willamette River). The more volatile COCs could potentially volatilize from soil or groundwater into soil gas, which could migrate to ambient air. Based on the extensive characterization of the site, volatile constituents are present only in a couple of the hot spot areas. For the remainder of the site the potential for soil vapors to migrate to outdoor or indoor air is negligible. Groundwater at the site is not a current source of drinking water. However, drinking water is a potential beneficial use of groundwater. In addition, shallow groundwater could migrate downward to deeper water-bearing zones, which could potentially be used as a drinking water source. Drinking groundwater is therefore a potential exposure mechanism. Since groundwater discharges to the Willamette River, exposure of ecological receptors to surface water will be considered a potentially complete pathway. The soil and groundwater data collected during the data gaps investigation (AMEC Geomatrix, 2010b) and historical investigations support the conclusion that the risk of COC migration from soil to groundwater is considered low, except possibly for groundwater immediately downgradient of the more impacted hot spot areas. The removal action in these hot spot areas needs to address potential migration of COCs via groundwater. For the remainder of the site, soil is not expected to produce impacts to groundwater at levels of concern for surface water or drinking water, as discussed in Section 2.6.3 above.

Potential receptors and pathways, human and ecological, differ for different areas of the site. Contaminants in RS areas have a greater potential to migrate to the Willamette River via stormwater runoff, wind erosion, and/or river bank erosion. Exposure for the RS areas is therefore anticipated to be greater for both human and ecological receptors. Potential receptors and exposure pathways are evaluated in the following sections.

2.7.2 Human Health Assessment

Figure 8 summarizes the potential human receptors and complete exposure pathways. Based on the CSM presented in Section 2.7.1, the following exposure pathways and receptors are considered complete or potentially complete:

- Neighborhood residents/recreational users may be exposed to COCs in fugitive dust via inhalation or have direct contact with COCs in uncovered surface soil, resulting in exposure via dermal contact or incidental ingestion. The frequency of such visits is expected to be much lower than that of students and staff, and as well the duration of any visit would also be much less. However, neighbors living in the area could be visiting the site for many years. Assumptions used for the Portland Harbor Superfund site (Kennedy/Jenks Consultants, 2009) regarding recreational users are conservatively assumed for the River Campus property in this EE/CA, and such users are assumed to include both adults and children.
- Occupational users (university students, staff, etc.) would have similar risks as neighborhood residents and recreational users, but exposure frequency and duration would be expected to be higher as these groups could be regular users of the site. Student exposure would occur for a relatively short period, whereas UP staff could be exposed to COCs over the long term.
- Temporary construction workers, present at the site for short durations, may be exposed to COCs in surface and subsurface soil via direct contact while completing construction activities involving excavation, resulting in incidental ingestion, dermal contact, and/or inhalation of fugitive dust. These workers could also potentially have direct contact with shallow groundwater, resulting in incidental ingestion and/or dermal contact during excavation work, although the depth to groundwater is greater than most excavation work.
- Few permanent residents live on the campus and no residences are planned for the River Campus site. Students live in dorms on the upper portion of the campus for at most 4 to 6 years and generally for less than 9 months a year. The River Campus area (the site) is not planned for dorms or any other form of residential housing in the near term or long term.

2.7.3 Ecological Assessment

The site has been used for industrial purposes for many years and has remained mostly vacant for all practical purposes for the last decade. Most of the site has been cleared of vegetation, although low brush and similar vegetation occurs sporadically across the site and could serve as habitat for other plants and wildlife. The site is anticipated to be redeveloped as part of the UP campus, with the entire site, except along the river shoreline, being converted to building, parking lot, sports fields, or landscaped areas. UP may consider setting aside parts of Areas 2A and 3B as native white oak habitat consistent with discussions between UP and the City of Portland.

The Willamette River, bordering the site on the west, is used as a maritime shipping channel maintained by the US Army Corps of Engineers with a depth of approximately 40 feet (MFA, 2002a). The river provides habitat for ecological receptors, such as fish (including salmonids, sturgeon, and lamprey), aquatic invertebrates, aquatic mammals (including muskrats and otter), terrestrial mammals, and birds, including fish-eating species, such as herons, eagles, and osprey.

Figure 8 charts the potential ecological receptors and complete exposure pathways at the site. Complete or potentially complete ecological exposure pathways at the site comprise the following scenarios:

- Direct contact pathway - Small birds, rodents, and rabbits, terrestrial biota that live and feed at the site could be exposed to contaminants of concern through contact with, ingestion of, or inhalation of particulates from soil.
- Soil to Surface water pathway– Since impacted portions of the site border the Willamette River, aquatic biota can potentially ingest constituents from the site that migrate to the river and/or to river sediments.

Both these pathways could result in food chain accumulation.

2.7.4 Summary of Calculated Risks

To aid in the determination of where a removal action is warranted, AMEC calculated total and individual COC risk for each MIS decision unit area. An occupational/industrial use scenario of the property and application of EPA's relevant Regional Screening Levels (RSLs) (EPA, 2011a) best represent anticipated long-term use of the property and risks that are likely to occur (Section 2.3) and is the same approach utilized by DEQ for the Triangle Park ROD. The site is not going to be used by UP for residential use but will be used for specific campus activities as previously described above. The site may be used recreationally by both students, staff and neighborhood visitors but an occupational/industrial use scenario is considered more conservative as it assumes long term exposure to COCs by UP staff.

The method applied to calculate risk is consistent with EPA guidance and was based on formal comments and recommendations from EPA after their review of the draft EE/CA. The results of the calculations are provided in full in Table 8, and a summary is provided in Table 9.

The calculated values shown in Table 8 were completed using the existing MIS data applied to each decision unit. The decision units were defined for the entire MIS sampling interval from 0 to 10 ft. The calculations were performed via the following steps:

1. For each decision unit the highest concentrations of detected carcinogenic compounds for the various MIS sampling depths were divided by the carcinogenic EPA RSL (both residential and industrial values) (EPA, 2011a) and then multiplied by 1E-6. Those values were then summed to come up with a total carcinogenic risk value for the decision unit under residential and industrial scenarios and individual risk values for each COC. The results of these calculations are shown under the column headed *Risk* in Table 8.

2. For each decision unit, the highest detected concentrations of non-carcinogenic COCs for the various MIS sampling depths were divided by the non-carcinogenic EPA RSL (both residential and industrial values) (EPA, 2011a). Those values were then summed to come up with a total non-carcinogenic HI value for the decision unit under residential and industrial scenarios. These values are shown under the column headed *Hazard* in Tables 8.

3. The results from Steps 1 and 2 were compared to a total risk of 1E-5 for carcinogenic compounds, a HI of 1 for non-carcinogenic compounds, and a risk of 1E-6 for individual carcinogenic compounds based on the highest detected concentration of any individual COC. EPA generally considers a risk in the range between 1E-6 and 1E-4 to be acceptable and therefore not trigger a removal action (EPA, 1991), however for the River Campus property, a cumulative cancer risk of 1E-5 and a HI of 1 may be applied by EPA based on Oregon law and rules. Oregon Administrative Rule 340-122 stipulates acceptable risks. Under OAR 340-122-0115, acceptable risks include "cumulative lifetime excess cancer risk for multiple carcinogens and multiple exposure pathways of less than or equal to one per one hundred thousand at an upper-bound exposure." In addition, based on Oregon Law, the risk for each individual carcinogen may not exceed 1E-6. The results of these comparisons are summarized in Table 9.

4. The results of the risk calculations were evaluated to determine the main drivers for risk in each area. In some MIS areas, risk was driven entirely by arsenic and/or by compounds where the laboratory reporting limit exceeds EPA RSLs. At the River Campus property, arsenic concentrations generally range from 1 to 4 mg/kg, which is below the Portland Harbor area background concentration of 7 mg/kg. Since arsenic appears to be naturally occurring at the property and levels are below the Portland area background concentration, arsenic concentrations should not be used as a driver for removal actions at this site. This approach is consistent with OAR 340-122, which indicates that in areas where concentrations of metals such as arsenic are above DEQ cleanup levels but below background levels, these metals should not be used to determine the need for cleanup. This rule indicates that the background level should be used as a standard for cleanup. Similarly, if concentrations of all COCs were below the limits of detection in an area, the area was not considered to require action.

Table 9 summarizes the results of the calculations from steps 1 through 4. Figure 9 summarizes these results for the property, and Figure 10 illustrates the results for each MIS decision unit area considered.

Using the methods described above, Areas 1B, 1C, 2A, 2A1, 2B, 3B (including all subareas), 5A, 5B, 6A, 6B, 6C, 6D (including subareas 6D1, 6D2, and 6D3), RS-1 (including subareas RS-1A, RS-1B, and RS-1C), RS-2, and RS-3 exceed either a cumulative cancer risk of 1E-5 using residential RSLs, or a risk for an individual compound using residential RSLs of 1E-6. As noted above under step 4, in some decision units, risk exceeded the threshold values for residential risk, but the risk was driven only by arsenic concentrations and/or only by a laboratory detection limit exceeding RSLs for non-detected analytes.

Areas 1B, 2A, 6A, 6B, 6D, and RS-1 exceed a risk of 1E-6 for an individual carcinogens using occupational RSLs or a cumulative cancer risk of 1E-5 based on occupational RSLs. Only Area 1B exceeds a carcinogenic risk greater than 1E-4. Areas 1A, 3A, and 4 were found not to exceed threshold risk using either residential or occupational RSLs, except for Area 4 arsenic and compounds with elevated detection limits.

Use of risk evaluations in determining removal actions should consider the fact that the risk assessment process is based on many assumptions that can result in either an over or under-estimate of actual risks. .

2.7.5 Summary of DEQ ROD Risk Assessment

The DEQ ROD assessed occupational/industrial human health and ecological risk. Unacceptable risk of greater than 1×10^{-4} was calculated for area AOC5 (Table 3 of the DEQ ROD). AOC5 encompasses Areas 5A, 5B, and RS-2 as defined in this EE/CA, and includes three of the ROD defined hot spots. The estimated risk at all other areas of the site evaluated as part of the DEQ ROD was less than 1×10^{-4} . Risk was primarily from metals and PAHs. The ROD also determined that there may be an unacceptable risk to avian and mammal populations due to lead, PAHs, PCBs, and dioxins. The results of the risk assessment performed as part of the work under the ROD were used to develop screening level values used for assessing hot spots that required action. Figure 5 shows the hot spots identified for action in the DEQ ROD, for both excavation and capping.

2.7.6 General Conclusions

Addressing the most direct pathways for human health and ecological exposure at the site will greatly reduce the risks posed by the COCs present at the site. The risk of exposure of human and/or ecological receptors at the site is summarized below for each of the three types of areas (see Figure 9):

1. **The MIS Upland Areas:** These areas represent relatively large areas of several acres, most of which have relatively low concentrations of COCs. The COCs in these areas include metals, PCBs, dioxins, and/or PAHs, which all have low mobility in the subsurface environment and present a minimal risk to groundwater and the river. The primary exposure pathways are direct contact and dust inhalation. Given the academic campus

setting, these pathways present an exposure period that is much shorter in duration on both a daily basis and a long-term basis than residential exposure. As a result, the residential risk scenario is not considered applicable for this exposure pathway. Exposure of university workers and students is a more appropriate scenario to consider for evaluation of the human risk exposure.

2. **The MIS River Shoreline (RS) Areas along the Willamette River bank:** These long, narrow areas border the river and present a high potential risk for COCs present in these areas over time (without runoff control) to migrate to the river, via the primary pathways of stormwater runoff and erosion. For these areas, the receptors include both human (ingestion of fish, and direct contact) and ecological.

3. **The potential "hot spot" areas:** Direct releases have resulted in soil contamination in localized areas, and these are generally considered source areas. The COCs vary from hot spot to hot spot and include mostly petroleum products, but also include PCBs, dioxins, and metals. Six of these locations were identified previously in the DEQ's 2005 ROD and under the terms of the ROD have been selected for excavation and off-site disposal. Seventeen locations were identified in the DEQ ROD and under the terms of the ROD have been selected for capping. Other potential hot spot areas were identified and characterized in subsequent investigations. The hot spot areas generally represent the most impacted areas on the site and present therefore the highest risk to the environment. Some of these areas represent greater risk based upon the magnitude of COC concentrations, the mobility of the COC, location near the river bank, and/or the depth of the impacts (proximity to the surface representing a greater risk).

2.7.7 Basis for Action

The EPA Office of Solid Waste and Emergency Response (OSWER) Directive 9355.0-30, "Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions," provides guidance on how to use the baseline risk assessment to make risk management decisions such as determining whether remedial action under CERCLA Sections 104 or 106 is necessary. It states "Generally, where the baseline risk assessment indicates that a cumulative site risk to an individual using reasonable maximum exposure assumptions for either current or future land use exceeds the 10(-4) lifetime excess cancer risk end of the risk range, action under CERCLA is generally warranted at the site. For sites where the cumulative site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10(-4), action generally is not warranted, but may be warranted if a chemical specific standard that defines acceptable risk (e.g., MCLs) is violated or unless there are non-carcinogenic effects or an adverse environmental impact that warrants action. A risk manager may also decide that a lower level of risk to human health is unacceptable due to site specific reasons and that remedial action is warranted."

For the River Campus uplands property, only one MIS sample had COCs posing a residential risk in excess of 1E-04, and one area from the DEQ ROD had occupational risk in excess of 1E-04; however, there are site-specific reasons for taking action at a lower risk level. Under the terms of the BFPPA entered into between UP and EPA, the parties have agreed that, at a minimum, the removal action work at the site must meet the objectives of the 2005 ROD. The state cleanup standards require cleanup where the potential human health risk exceeds a cumulative cancer risk of 1E-05, individual chemical cancer risk of 1E-06, non-cancer risk exceeds an HI of 1, or risks to ecological receptors are unacceptable. Based on the results of site characterization and risk evaluations described in previous sections and the criteria above, response actions for soils appear to be warranted at this site.

For the RS areas, contaminated soils have a significant potential to erode or migrate into the Willamette River, thereby contaminating sediments and impacting ecological receptors. Comparison of MIS sampling results to the draft Portland Harbor preliminary remediation goals (PRGs) results in estimated potential human health risks greater than 1×10^{-4} , HI greater than 1, and/or ecological risks exceeding an HI greater than or equal to 1, such that action appears to be warranted for the RS areas.

No action appears to be warranted for groundwater except to ensure that site COCs are not increasing in groundwater.

3.0 REMOVAL ACTION SCOPE, OBJECTIVES, AND GOALS

As summarized in previous sections, based on site conditions, risks posed at the site, and terms of the BFPPA entered into between UP and EPA, response actions appear to be warranted at this site.

This section describes the scope, objectives, and preliminary remediation goals for the proposed response action and the basis for each of them. It also discusses the proposed approach evaluated in this EE/CA, including areas on site where action is needed based on these criteria.

3.1 DETERMINATION OF REMOVAL SCOPE

The response actions evaluated in this EE/CA are intended to be a final action for this property and to be consistent with potential future remedial action at the wider Portland Harbor site. To serve as the final action, the response action selected will need to be protective (addressing the human health and ecological risks identified within the streamlined risk evaluation provided in Section 2.7), based on current and reasonably anticipated future land use, comply with applicable or relevant and appropriate requirements (ARARs), and be consistent with the 2005 DEQ ROD, Oregon PPA, and federal BFPPA. This EE/CA assumes all areas identified for response action in the DEQ ROD and other areas of contamination exceeding PRGs where new information has become available through site investigations and this EE/CA will be addressed by the removal to be selected in the Action Memorandum unless otherwise noted.

Other significant factors in planning the scope and objectives of the proposed response actions are that the site is currently fenced and unused, the reasonably anticipated future land use for the site is as a campus and recreation area, and that the site will not be used for residential purposes.

Groundwater contamination at the site based on the most recent sampling slightly exceeds screening levels for select constituents, including metals, PAHs, and TPH. DEQ's 2005 ROD concluded that although some impact to shallow groundwater is present on site, residual soil contamination remaining on site following soil cleanup is not expected to significantly impact groundwater in the future. Recent results from MIS sampling support earlier findings that show that most of the COCs that exist at the site are present in near-surface and shallow soils, with concentrations decreasing with depth. Typically, contaminant concentrations in soil decrease to low or nondetectable levels at depths above the water table Therefore the scope and objective of response actions associated with groundwater evaluated in this EE/CA is limited to preventing migration of further contamination from soils to groundwater.

3.2 GOALS AND OBJECTIVES OF REMOVAL ACTION

Removal action objectives (RAOs) provide a general description of what a response action will accomplish. They are written in terms of the contaminants and media of concern, potential exposure pathways, and removal goals. RAOs have been developed for the site based on the objectives of the DEQ ROD and an analysis of the sources of contamination, the nature and extent of contamination, and the results of the human health and ecological risk evaluations. The potentially exposed populations of concern include construction and maintenance workers, faculty and students, neighbors and other recreational users of the property, and ecological receptors (birds and mammal populations). Following the narrative of RAOs is a discussion of the preliminary remediation goals associated with the RAOs and the basis for them. These preliminary remediation goals have been used in this EE/CA to identify the areas of the site which appear to warrant action and to evaluate and compare alternative actions to achieve the RAOs. EPA's Action Memorandum will specify the areas of the site which require action and select final cleanup levels as the goals to be achieved by the response actions in those areas.

3.2.1 Removal Action Objectives

The RAOs for the property used to evaluate alternatives in this EE/CA are as follows:

- Prevent human exposure, through ingestion, direct contact, or inhalation, to site COCs in soils above concentrations that allow for unrestricted use and unlimited exposure;
- Prevent the spread or migration of contaminated soil at the site into surface water and sediments, protect aquatic receptors from exposure to unacceptable levels of contaminants, protect humans consuming fish or other biota, and comply with ARARs;
- Prevent migration of site COCs above acceptable levels to groundwater to protect drinking water resources and potential human and aquatic receptors, and comply with ARARs; and
- Prevent or minimize the potential for ecological receptors (birds and terrestrial mammals) to be exposed through ingestion of or direct contact with site COCs in soils that pose unacceptable risks.

3.2.2 Preliminary Remediation Goals

This section presents the PRGs associated with the RAOs described above and the basis for them. Following public comment on the EE/CA these PRGs will be refined in final contaminant-specific cleanup levels that will be documented by EPA in the Action Memorandum. CERCLA and the NCP require that removal actions be protective of human health and the environment and comply with ARARs to the extent practicable. Given the intention to make this the final action for the River Campus property, the removal actions will need to fully comply with ARARs (or justify a waiver) and be consistent with potential future remedial action at the wider Portland Harbor NPL Site. Furthermore, under the terms of the BFPPA entered into between UP and EPA, the parties have agreed that the removal action work at the site also must meet the objectives of the 2005 ROD but may require additional removal actions.

The requirement to also be consistent with the potential future remedial action at the wider Portland Harbor NPL Site does not affect the PRGs and cleanup levels for most Upland soils, as they are not expected to migrate to the river. However, the PRGs and cleanup levels for the River Shoreline areas also need to comply with the Portland Harbor PRGs dated March 27, 2009, due to the potential for contaminated soils to migrate or be released from the shoreline into river sediments. Because they are sediment-based, the Portland Harbor PRGs are in some cases more stringent than the Oregon Cleanup rules and other ARARs, so there is one set of PRGs for the Upland Soils (Table 10) and a second set of PRGs for RS soils (Table 11). Table 11 indicates the current minimum and maximum range of risk based screening levels for contaminants in river sediment. EPA will select a cleanup level within the range of risk indentified by the draft Portland Harbor PRGs in the Action Memorandum.

The lowest of the following screening criteria and potential ARARs, as shown on Tables 10 through Table 12, have been used in this EE/CA to develop preliminary remediation goals based on RAFLU.

- EPA Regional Screening Levels (EPA, 2010), which are risk-based screening levels, calculated using the latest toxicity values, default exposure assumptions, and physical and chemical properties, for which default parameters can be changed to reflect site-specific risks. The calculation of cumulative risk level, as described in Section 2.7.4, employs EPA RSLs for soil under occupational/industrial and residential scenarios to determine calculated risk for MIS decision unit areas and to determine screening levels for soils to be protective of groundwater;
- Portland Harbor draft PRGs; and
- Potential ARARs used in this EE/CA to develop preliminary remediation goals and for the evaluation of alternatives:
  - Federal Safe Drinking Water Act (42 U.S.C. § 300f et seq., 40 CFR §141): The primary drinking water standards address toxicity and are termed maximum contaminant levels (MCLs) (Table 12). MCLs are potential ARARs for actual and potential drinking water sources, which for this site include groundwater beneath the site and surface water in the adjacent Willamette River.
  - RCRA regulations [40 CFR § 265.111 (Closure Performance Standards), CFR § 265.117 (Post Closure Care), and 40 CFR §265.310 (Landfill Closure)] are potential ARARs for any response actions involving capping and/or disposal of contaminated soils or debris.
  - Clean Water Act (33 U.S.C. §§ 1313, 1314; 40 CFR §131) Ambient Water Quality Criteria: Federal Water Quality Criteria form the basis of Oregon water quality standards (OAR 340-041) and are potential ARARs for protection of surface water, ecological receptors, and people exposed to either.

- OAR Oregon Environmental Cleanup Rules (OAR 340-122) are the basis for the cleanup standards in the DEQ ROD and potential ARARs for response actions required by the EPA Action Memorandum following consideration of public comment. OAR 340-122-0040(2) requires that hazardous substance response actions achieve one of the following standards:

  - Acceptable risk levels defined in OAR 340-122-0115, as demonstrated by a residual risk assessment; or
  - Numeric cleanup standards developed as part of an approved generic remedy identified or developed by the Department under OAR 340-122-0047, if applicable; or
  - For areas where hazardous substances occur naturally, the background level of the hazardous substances, if higher than those levels specified in subsections (2)(a) through (2)(b) of this rule.

Acceptable risk levels as set forth in OAR 340-122-0115 stipulate that acceptable risk levels include:

- "for human exposure to individual carcinogens… a lifetime excess cancer risk for each carcinogen of less than or equal to one per one million [1E-6] for an individual at an upper bound exposure;" or "a cumulative lifetime excess cancer risk for multiple carcinogens and multiple exposure pathways of less than or equal to one per one hundred thousand [1E-5] at an upper-bound exposure;" and
- for noncarcinogens, "a hazard index less than or equal to one for an individual at an upper-bound exposure."

The 1E-6 level is also the risk level the NCP says shall be used as the point of departure for determining removal goals and cleanup levels for known or suspected carcinogens, once action has been determined to be warranted.

3.3 PROPOSED APPROACH

As described more fully in Section 6, in order to guide the development and evaluation of the effectiveness, implementability, and cost of each alternative to achieve the RAOs and statutory requirements for this Site, subareas have been developed and grouped based on COC concentrations and comparison to PRGs and RAOs in accord with the NCP, ARARs, and the 2005 DEQ ROD. Based on these criteria, five groups of areas/subareas have been identified (Figure 9):

- **No Action Areas:** Upland areas with soils below unlimited use and unrestricted exposure levels appear to be acceptable as is without any response action.
- **Limited action areas**: Upland area soils with COC concentrations below active response thresholds but above levels that allow for unlimited use/unrestricted exposure (risks between 1E-05 and/or HI greater than 1 based on occupational/industrial use and 1E-06 and/or HI greater than 1 assuming residential use) appear to warrant only limited action. A subset of the upland area soils fall into this category.

- **Active response action areas**: Areas with soils which exceed certain thresholds described below appear to warrant active responses, such as treatment, excavation and/or capping, and if the active response leaves waste in place above levels that allow for unlimited use/unrestricted exposure, ICs would also be required. Active response action areas include:

  - **<u>River Shoreline (RS) Areas</u>**: For the RS areas, response actions need to be protective of public health and the environment, comply with the DEQ ROD cleanup requirements, comply with ARARs to the extent practicable (or comply completely for this to be a final action), and be consistent with and contribute to the efficient performance of anticipated long-term remedial actions for the greater Portland Harbor NPL Site, which encompasses this Site. Because RS soils have the potential to slough or migrate into the river and affect sediments, EPA has determined that RS area actions should also comply with the draft Portland Harbor NPL Site PRGs (March 2009). All the RS areas exceed the most stringent of the above criteria, as shown in Table 2, including the draft Portland Harbor Site PRGs as of March 2009, and appear to warrant active response action;

  - **<u>Portions of the Upland Areas</u>**: Active response actions are evaluated for those upland areas where the DEQ ROD requires active response, or subsequent sampling and risk assessment has identified soils posing potential carcinogenic risk greater than 1E-04, or non-cancer risks greater than an HI = 1. Note that upland area soils are not considered likely to migrate to river sediments, so Portland Harbor PRGs have not been used to guide response action decisions in Upland Areas.

- **Hot spot areas**: All areas that were designated as Hot Spots in the DEQ ROD will require an active response. One additional area that was found during the removal assessment is also subject to the Hot Spot criteria requiring excavation.

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4.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION TECHNOLOGIES

This section identifies available and appropriate technologies for potential response actions, consistent with the scope, role, and RAOs for the site described in Section 3.0. It is assumed that excavation and disposal will be the likely option to address hot spot areas that warrant a removal action. For the large, less-impacted areas, removal action technologies have been identified based in part on the 2005 DEQ ROD (DEQ, 2005). The main technologies identified in the ROD and identified in this EE/CA as appropriate for the site are described below.

4.1 NO ACTION

Under this alternative, no action would be taken to remove, treat, or contain contaminated media at the site. Contaminated media would remain on site, and the potential for migration of contaminants or exposure to site receptors would not be addressed.

4.2 INSTITUTIONAL CONTROLS

Institutional controls may be implemented as a stand-alone removal action technology or be combined with other measures or technologies as part of an option. EPA defines *institutional controls* as non-engineered instruments, such as administrative and legal controls, that help minimize the potential for human exposure to contamination and/or protect the integrity of the remedy.

For the River Campus property, soils that contain concentrations of COCs that pose a potential risk exceeding the threshold risk level based on the residential exposure scenario will need to be considered for removal action in this EE/CA. These areas will require, at minimum, institutional controls to reduce exposure to contamination by limiting land use where and for as long as COCs remain at the site above these residential threshold risk levels. An additional objective of institutional controls at the site would be to reduce the potential for disturbance or spread of soils left in place following any removal action that contain concentrations of contaminants above residential or occupational risk levels, so as to reduce the risk of contaminant migration.

This section describes the institutional controls that will be evaluated for the River Campus property.

4.2.1 Institutional Controls Identified in the 2005 Record of Decision

As described in Section 2.2.4, the 2005 DEQ ROD recommended the implementation of specific institutional controls at the site, including a deed restriction and DEQ-approved Soils Management Plan. The deed restriction or proprietary control would take the form of a EPA and DEQ-approved *Easement and Equitable Servitude* pursuant to State law that identifies the site remedy and ongoing management requirements on the property. The *Easement and Equitable Servitude* provision would become part of the deed to the property and be enforceable by DEQ and/or EPA. The EPA and DEQ-approved *Soils Management Plan* would address (1) notice to site workers of the presence of soil contamination; (2) how soil stockpiles that may be generated at the site will be characterized, managed, and disposed of; (3) maintenance of residual contaminant concentrations in newly exposed surface soil (0-3 feet bgs) at levels protective of human and terrestrial and aquatic ecological receptors; and (4) site health and safety requirements regarding currently existing contaminated soil for any future site redevelopment activities.

4.2.2 Zoning Restrictions

Zoning restrictions would prevent site land uses, such as residential uses, that are not consistent with the level of cleanup at the site. As previously mentioned, the zoning designation for the site has recently been changed from Heavy Industrial (IH) to General Employment 2 (EG2) to accommodate UP's future use of the site. General Employment zones do not allow for residential uses, except those approved through the conditional use review process. Daycare facilities, however, are allowed in EG2 zones. Since the zoning designation for the site has already been changed to accommodate redevelopment plans, implementation and maintenance of this institutional control would require little to no effort and would have no associated costs.

4.2.3 Hazard Communication Plan

The UP could adopt a hazard communication plan that notifies university staff, students, visitors, and the surrounding community regarding the areas where contaminated soils are contained on site such as contaminated areas that are capped. This plan would help to further reduce potential human exposure to COCs and damage or disturbance of the cap. Development, implementation, and maintenance of a hazard communication plan would be the responsibility of UP. Methods for communicating site hazards may include training for university staff, disclosures in campus and community publications, and/or posting of signage at the site.

Institutional controls are not generally a stand-alone alternative, though potentially, in the areas where soils exceed residential and occupational risk thresholds (i.e., soils containing COCs at levels that create a total risk greater than 1E-5 or an individual COC risk greater than 1E-6 or an HI of 1), but are below active response thresholds (i.e. soils containing COCs at levels that create a total risk greater than 1E-4 or an HI greater than 1), institutional controls may be determined to be sufficient to meet the removal action objectives.

Institutional controls may serve as the final action on a large portion of the site, but may also be implemented in combination with other technologies, including capping, on other parts of the site. All removal action options that include leaving soil on site above levels exceeding residential RSLs will likely include institutional controls.

4.3 Excavation and Off-Site Disposal

In areas where excavation and off-site disposal is the selected alternative, soil exceeding action level criteria would be excavated, loaded into haul trucks, and transported to an approved, off-site waste disposal facility. Excavated areas would be backfilled with imported suitable clean soil.

Excavation is an effective method for physically removing subsurface material containing constituents exceeding concentrations that represent unacceptable risk to human and/or ecological receptors. Excavation is required to remove source-level concentrations that have been identified as hot spots in the DEQ ROD, and will also be an appropriate technology for those other areas that fit the Oregon definition of a hot spot (exceeding 10 to 100 times DEQ commercial RBCs, EPA RSLs, or, in shoreline areas, Portland Harbor PRGs, JSCS SLVs, or representing a clear risk to groundwater or surface water). In areas where this technology is selected, soils above the risk threshold would be excavated and removed from the location. Because excavation and removal to an off-site facility involve the use of standard construction equipment, there are few practical limitations on the types of waste that can be excavated and removed.

Soil above the removal action levels in any designated area or subarea may be excavated as long as side slopes of 1.5 horizontal to 1 vertical (1.5:1) are maintained to access the deeper excavation areas. Confirmation samples will be expected to be taken to confirm soils remaining in place meet cleanup criteria unless other technologies, such as capping or institutional controls, are combined with excavation to reduce risk of exposure by potential receptors.

Excavation and off-site disposal has the advantage of completely removing the contamination from the site and eliminating any need for further actions, including institutional controls, maintenance, or monitoring. On the negative side, excavation and off-site disposal does not eliminate the risk from these soils by permanently destroying the COCs but simply transfers them to a disposal site where they will need to be managed long term. In addition, truck traffic and the nuisance and safety risks of traffic are a concern for both the removal of soil and import of replacement clean fill.

In some areas, excavation may be chosen to remove the most highly impacted soils only, as opposed to removing all soils above residential-based exposure levels. In these cases, institutional controls would need to be included at a minimum to protect human health and the environment.

4.4 Excavation and On-Site Management (Re-Use On Site)

Excavation can be implemented in some areas of the site with excavated soils relocated to another area of the site and reused as backfill material. This technology is applicable where soils have levels of contamination that are either below residential exposure criteria for the area proposed for reuse, or that the soils will be managed accordingly, such as implementation of institutional controls or, depending on the concentrations, capping to prevent exposure. This technology is particularly viable as an option to manage soils from areas adjacent to the river. In most cases, these soils exceed draft Portland Harbor PRGs applied to areas adjacent to the river, but do not exceed hot spot criteria, and levels of contamination are similar to areas being addressed in the uplands. If soils meet the residential and ecological risk-based criteria, they could be used on site, without restrictions, for any purpose, including use as cap material. If soils exceed PRG levels, the use of these soils must be consistent with the removal actions chosen for soils exceeding upland PRG levels.

4.5 CAPPING

This technology involves placement of a permanent cap above the soils with concentrations of COCs that exceed cleanup levels. The cap would consist of either:

1. A clean layer of soil a minimum of 2 feet thick, topped with a grass/vegetative cover;
2. An equivalent cap, such as gravel (e.g., a gravel parking lot), paved parking lot, concrete, or building; or
3. A combination cap, such as clean soil overlain by asphalt or part of the area covered with a soil cap and part of the area covered with an equivalent cap.

Establishing a cap protects human health and the environment by:

- Eliminating direct contact of human and ecological receptors with constituents exceeding cleanup levels in shallow soils;
- Isolating soils containing constituents exceeding cleanup levels, thereby eliminating dispersion by wind and/or surface water runoff; and
- Minimizing the potential for construction worker exposure to soils containing constituents exceeding cleanup levels during daily site work.

Capping does not protect workers during deeper trenching preparation or utility installation activities.

To eliminate the risk of simple dermal exposure to contaminated soils, capping with clean soil a minimum of 2 feet thick is sufficient as this thickness minimizes the risk of direct exposure pathways. A 2-foot-thick cap is also sufficient to provide the following benefits:

- Protect against minor erosion of the cap;
- Allow minor, shallow ground disturbance, such as to allow landscaping and planting of shrubs and flowers;
- Eliminate surface water contact with COCs and the potential migration of COCs via surface water;
- Provide a necessary buffer for minor damage or erosion; and

- Eliminates the airborne (dust) exposure pathway for COCs.

For a migration pathway such as air inhalation or migration to groundwater and ultimately to surface water, a thicker cap or a low-permeability cap would normally be required. However, except in the hot spot areas that are assumed to require excavation and off-site disposal, air inhalation and migration to groundwater and ultimately to surface water are not considered significant exposure pathways at the site due to the characteristics of the specific COCs present, as discussed in Section 2.6.4. For the purposes of this EE/CA and cost analysis, a 2-foot-thick cap has been assumed as appropriate for all capping necessary at the site.

RCRA regulations [40 CFR § 265.111 (Closure Performance Standards), CFR § 265.117 (Post Closure Care), and 40 CFR § 265.310 (Landfill Closure)] establish performance standards that may be relevant and appropriate for the construction and maintenance of caps to the extent that the caps are being designed to prevent direct contact with surface soil contamination. These regulations are potential ARARs for consideration in the final cap design.

The need for capping of a particular area would be based on the risk calculated for that area.
In general, if an area requires action to address contamination, capping or another removal action option is likely to be required to eliminate the risk. Capping as outlined above may not provide sufficient protection if COC concentrations are extremely high such that a risk exists for mobility of COCs to groundwater or air (soil vapors). Although it is assumed in the EE/CA that capping would utilize clean imported soil only, other capping options may be appropriate. Since the role of the cap, in most of the areas, is simply to minimize potential contact with soils that are above cleanup levels, other capping forms can meet the same objective. At the time of this EE/CA, UP has not developed nor obtained permits to develop the River Campus property. However, the site development plans include many areas of the site that are expected to be covered (capped) by a building structure, sports field, or parking lot (Figure 4). Building foundations and or asphalt/concrete parking lots would serve an equivalent function as a 2-foot-thick soil cap. Design of sports fields, such as practice fields or a planned new baseball stadium, could potentially incorporate a soil cap. Alternative cap designs will be evaluated in more detail during the design phase of the removal action process following selection of the recommended removal action.

For the purposes of this EE/CA, the soil cap technology is assumed to consist of a minimum 2-foot-thick layer of clean soil placed and compacted consistent with City of Portland fill requirements. The soil used in the cap must be deemed “clean” based on a protocol expected to be established during the design phase. A vegetative layer, such as landscaping soil, would not be included as part of the thickness of the soil cap but is assumed to be required in addition to the soil cover. The 2-foot-thick soil cap would be placed over the contaminated soil with a separation layer of a geotextile. The geotextile is intended to provide a visible indicator to distinguish the capping soil from the underlying contaminated soil during activities that could disturb the cap, such as landscaping, and thereby prevent the cap from accidentally mixing with the underlying contaminated soils. The geotextile also prevents erosion of the underlying soils in the potential case of surface water erosion through the cap layer. The exception to this is the areas identified for capping in the 2005 DEQ ROD. They would be capped with a two-inch asphalt cap, as specified in the DEQ ROD.

Long-term monitoring of the cap's structural integrity along with regular maintenance of the cap would be required to preserve the integrity of the cap over time. Monitoring would be documented in a long-term operation and maintenance (O&M) plan as part of the final implementation design. The O&M plan would include a cap monitoring schedule.

This technology would leave soils in place with concentrations of COCs above residential threshold risk levels. Therefore, institutional controls as described in Section 4.2 would also be required with this technology.

4.6 Groundwater and Long-Term Monitoring

Soil remedies that contain soil on site with COC concentrations that present a known risk to groundwater are typically accompanied by long-term groundwater monitoring to confirm that migration of COCs is not occurring. It is not anticipated that this will be the case for this site in areas where contaminated soils remain on site and are capped. Contaminants that remain on site would be COCs with low potential for subsurface groundwater migration. Metals, PCBs, dioxins, and PAHs are the COCs that are likely to remain, and each of these classes of COCs has low mobility. Hot spots are the most likely areas to present a risk to groundwater; however the hot spots are assumed to be areas requiring excavation and off-site disposal consistent the 2005 ROD. Monitoring of groundwater wells flanking the river would be necessary following implementation of the removal actions in order to assess whether migration of remaining COCs toward the river is occurring. Wells along the shoreline area would be necessary for this purpose, and a groundwater monitoring plan would be included as part of the removal action design phase.

5.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION OPTIONS

This section describes and evaluates alternative removal actions for the River Campus property. The options described in this section are evaluated based on the short- and long-term aspects of three criteria: effectiveness, implementability, and cost. These criteria are described in Section 5.1. The individual options are described in Sections 5.2 through 5.6.

In evaluating removal action options for the River Campus site, it is critical to recognize that site characterization using the MIS approach divided the site by historic use into 22 distinct sampling areas and subareas. The MIS approach, which is a statistical risk-based approach to the site, also divides the individual areas up vertically, resulting in different depth intervals; however, the risk-based approach used to determine the need for removal actions for this EE/CA as described in Section 2.7.4 evaluated each MIS Area for the entire depth of the MIS investigation and not by depth interval. Each sampling area contains different COCs with different action levels and potential ARARs. Accordingly, it is likely that the ultimate removal action will differ in different areas. Depending on the action being considered, the evaluation of a removal action also evaluated depth of contamination. For example, if excavation was being considered as a removal action for a given area, the depth intervals were reviewed to determine the necessary depth to excavate to address soils above the cleanup levels based on active response action thresholds.

To facilitate the evaluation of options, this report has combined the key technologies into likely viable removal options. Each option is evaluated generically as if it would be applied to the entire site. In practice, some options better address some of the areas/subareas, while other options would be more appropriate to implement at other areas/subareas. As a result it is possible that most if not all of the individual options described in this section could be used in different areas/subareas on the site. Section 6.0 identifies the option(s) that apply to individual areas and groups of areas. In general, options are developed and evaluated in Section 6.0 for groups of areas/subareas where COCs, concentrations, potential ARARs and other removal action goals are similar.

5.1 EVALUATION CRITERIA

This section describes the criteria that guide the evaluation of the various removal action options.

5.1.1 Effectiveness

Effectiveness is evaluated in terms of protectiveness and ability to achieve removal action objectives. The protectiveness of the options can be assessed in terms of how well they protect public health, protect workers during implementation, protect the environment, and comply with ARARs. Effectiveness includes the following evaluation factors:

- **Overall Protection of Human Health and the Environment:** Assesses the ability of the alternative to be protective of human health and the environment under present and future land-use conditions.
- **Compliance with ARARs:** Identifies whether or not implementation of the alternative would comply with all chemical-specific, action-specific, and location-specific ARARs.
- **Long-term Effectiveness:** Addresses the magnitude of residual risk remaining at the conclusion of removal activities; that is, addresses the adequacy and reliability of controls established by a removal action alternative to maintain reliable protection of human health and the environment over time.
- **Reduction of Toxicity, Mobility, and Volume through Treatment:** Identifies whether or not implementation of the alternative would reduce contaminant toxicity, contaminant mobility (e.g., preventing contaminated soil from reaching human receptors), or actual volume of the hazardous substances.
- **Short-term Effectiveness:** This criterion addresses the effects of an alternative during the construction and implementation phase until the removal action objectives are met. This criterion includes the time in which the remedy achieves protectiveness and the potential for adverse impacts on human health and the environment during construction and implementation of the alternative.

5.1.2 Implementability

The implementability of an alternative depends on technical feasibility, administrative feasibility, and the availability of necessary resources to support the alternatives. Implementability is evaluated in accordance with the following criteria:

- **Technical Feasibility:** Evaluates construction and operational considerations, as well as demonstrated performance/useful life.
- **Administrative Feasibility:** Evaluates factors such as statutory limits, off-site permitting requirements, easements/rights of ways, and impact on adjoining properties.
- **Availability of Service and Materials:** Considers availability of qualified contractors to handle off-site treatment; site preparation, design, equipment, personnel, services and materials, and excavation requirements; capacity for timely transportation and disposal capacity needed to maintain the removal schedule; and availability of disposal facilities licensed to accept hazardous and nonhazardous liquid/solid waste.

5.1.3 Cost

The estimated cost of the options described in this EE/CA is summarized in Table 13 for uplands areas/hot spots and in Table 14 for RS areas. Detailed cost estimates are provided in Appendix C. Estimated cost includes estimated disposal facility costs and the cost of soil reuse or clean import fill to backfill excavated areas, as noted.

5.2 Option 1: No Action

Under this option, no action would be taken to remove, treat, or contain contaminated media at the site. Contaminated media would remain on site, and the potential for migration of contaminants or exposure to site receptors would not be addressed.

This site-wide No Action option has been included as a requirement of the NCP and in order to provide a basis for comparison for remaining options. No costs would be involved in this option and no implementation would be necessary. However, this option is not considered effective in protecting human health and the environment for areas of the site that have been determined to require removal action based on the SRE or comparison to screening levels.

5.3 Option 2: Institutional Controls

Option 2 would use institutional controls to prevent residential use (and any other unacceptable uses) of all areas where COCs remain on site above levels that would allow unrestricted use/unlimited exposure (UU/UE) (based on risk under a residential exposure scenario), as well as additional controls to restrict disturbance of capped areas so as to prevent human exposure and prevent the spread or migration of COCs remaining on site under caps.

Institutional controls would consist of both administrative and legal controls. Administrative controls would include development of hazard communication plans for the campus to provide notice of contaminated soils present at the site and development of a health and safety plan for campus workers and contractors. Legal controls would include preparing and recording deed restrictions on the title to the property, such as a DEQ-approved EES. The deed restrictions would not allow residential development on the River Campus area of the University. Although large areas of the River Campus property are not contaminated, implementing a patchwork of deed restrictions on different portions of the property may not be optimal.

Institutional controls would meet overall site RAOs for those areas of the site with concentrations of COCs above the residential or occupational/industrial-based calculated cumulative risk of 1E-5 (or individual compounds exceeding residential risk of 1E-6 or an HI of 1), but below active response thresholds where total carcinogenic risk is greater than 1E-4, or non-cancer hazard is greater than1. Active response action thresholds were developed in Section 3.3 and Section 3.4 based on the results of the streamlined risk evaluation (Section 2.7), which in turn was based on the most likely scenario for use of the River Campus area. Based on the development of these levels, the site has been divided into three areas: (1) areas where active response is likely (exceeding threshold risk) or human health and ecological risk based on the Portland Harbor draft PRGs that apply only to the river shoreline areas;, (2) areas where limited response action is likely, such as institutional controls (exceeding threshold risk based on residential or industrial exposure, but less than carcinogenic risk of

1E-4, or non-cancer hazard of 1); and (3) No action areas (exceeding no established risk-based thresholds for either human or ecological receptors for the site). No residential development is planned for the River Campus property for the foreseeable future. Since the University will not use the property for residential use, soils containing COC concentrations above residential risk levels would likely require at a minimum institutional controls to protect the public over the longer term. Institutional controls would include language preventing residential use (and any other unacceptable uses) of all areas where COCs remain on site above levels that allow for UU/UE and additional controls restricting disturbance of capped areas so as to prevent unacceptable exposure or the spread of contamination.

5.3.1 Effectiveness

Administrative institutional controls are expected to be immediately effective at protecting the public from unacceptable exposure to COCs for soils that are below risk-based levels for the expected site users: campus employees, students, campus visitors, and recreational users (the occupational scenario). To assist in ensuring effectiveness, the University would develop a Hazard Communication Plan as described in Section 4.2.3.

Institutional controls alone would not meet all project ARARs. In particular, where concentrations of COCs exceed the active response threshold, institutional controls would not be adequate unless combined with an active cleanup technology, such as capping or excavation.

5.3.2 Implementability

Institutional controls may be quickly implemented both administratively and technically. Institutional controls are the weakest controls to maintain and enforce, and would require life-cycle maintenance and management until contaminants are degraded. As such, institutional controls would impose some long-term cost, and, if not maintained properly, could result in breach of the ICs.

Implementation of the majority of the recommended specific institutional controls at the site would require minimal effort, although long-term management may be more complicated. There are no unique technical requirements for implementing institutional controls. The services and materials needed to implement institutional controls are readily available and exist within the UP organization.

As described in Section 4.2.2, the zoning designation for the site has already been changed to accommodate redevelopment plans; therefore, implementation and maintenance of this institutional control would require little to no effort initially or long-term. Proprietary institutional controls are routinely written for contaminated sites using standard language developed by both EPA and DEQ. Hazard communication management is also easily implemented, although may be more difficult to manage long term. Development of a *Soils Management Plan* would involve a greater initial effort by UP to establish procedures for notification of site workers; characterization, management, and disposal of soil; maintenance of residual contaminant concentrations in newly exposed surface soil; and site health and safety requirements. Similarly, development of a hazard communication system would require some effort by UP initially, including determination of the most effective methods for providing information to employees, students, and the public. This effort may include development of a training program and development, production, and installation of disclosures and/or signage at the site. Implementation of the *Soils Management Plan* and hazard communication system would be more difficult to manage long-term due to the tendency for staff turnover to result in loss of institutional memory. To minimize this concern, management of institutional controls would be the responsibility of the UP facility maintenance department. Campus security would be part of the UP process to enforce the controls. The presence of these organizational structures is a distinct advantage in planning removal actions for a university campus.

5.3.3 Cost

Compared to active cleanup options, the cost to implement the institutional controls option is negligible. Costs involved in maintaining institutional controls over time are generally considered relatively low compared to the capital costs associated with more aggressive actions, particularly excavation and off-site disposal. However, unlike more intrusive action, institutional costs are long term. Institutional controls would need to be maintained for as long as soils remain on site above residential threshold risk levels.

Cost would be incurred to develop the *Soils Management Plan* and *Hazard Communication Plan*. In addition, a staff person with UP facility maintenance would need to have part of their role dedicated to ensuring compliance with the ICs. The majority of the costs would be borne during implementation of the removal action, with the long-term costs estimated to be less than $5,000 per year to maintain and comply with the ICs. Initial implementation costs could be on the order of $30,000 to $50,000.

5.4 OPTION 3: CAPPING

Option 3 assumes that soils impacted with COCs above cleanup levels would be capped and not excavated. This option assumes a cap with a minimum thickness of 2 feet of soil (or an equivalent alternative cap) to be placed over contaminated soils. The cap would be placed and compacted consistent with City of Portland requirements. The cap would be separated from the underlying contaminated soil by a geotextile. The purpose of the geotextile is to provide a visible separation between the capping soil and the underlying contaminated soil. This visible separation would help prevent mixing of the cap and underlying soils during activities that disturb surface soils, such as landscaping. The geotextile would also prevent erosion of the underlying soils that could potentially result due to surface water erosion through the soil cap layer. The cap would also be covered with a vegetative layer or other surface to prevent erosion of the capping material.

Alternatives to a soil cap could be used that perform an equivalent function. These alternatives include a building pad, asphalt or concrete parking lot, or sports field. In the case of a sportsfield, a natural grass field would still require the two foot thick soil cap below the vegetative layer; however, an artificial turf field typically is underlain by asphalt or concrete that would replace the soil layer. These alternatives would need to be sufficient to fulfill the function that a soil cap would fulfill (i.e., minimizing direct contact [direct human contact and surface water/wind contact]) with COCs.

Other components of this option would include institutional controls in the form of proprietary institutional controls to prevent residential use of the site and regular inspections and maintenance of the cap.

The effectiveness, implementability, and cost of Option 3 are detailed below.

5.4.1 Effectiveness

Option 3 is expected to be effective in protecting human health and the environment under present and future land use conditions. Soils with residual concentrations of COCs that exceed cleanup levels but do not represent a risk of migration to groundwater (and potentially to receptors in the river) nor otherwise represent a high risk to human health and the environment would be capped with clean soil to a minimum depth of 2 feet. The soil cap would eliminate mobility of COCs due to surface water runoff and eliminate direct contact of humans with soils exceeding cleanup levels based on anticipated future use of the site. Capping any soils with concentrations of COCs above cleanup levels would eliminate the risk of migration of COCs to surface water, since the COCs would not have direct contact with surface water and the COCs have low mobility in the subsurface and specifically in groundwater.

This option would meet potential ARARs for the specific area being addressed. Because some contaminated soils would remain on site, institutional controls would be necessary for short-term and long-term effectiveness. Recommended institutional controls, including proprietary institutional controls, for the site under the various options are described in detail in Section 5.3. Regular soil cap inspections and maintenance would ensure long-term effectiveness. Regular (annual) inspections of the cap would be performed to assess whether the soil cap has eroded or if areas of subsidence have appeared. The proposed geotextile separation layer would serve to minimize accidental mixing of the underlying COC-impacted soils with the cap layer, protecting against potential erosion due to major stormwater events, and minimize the potential for erosion to expose underlying soil.

This option is effective for addressing metals, PCBs, dioxins, and low-mobility (heavy) PAHs at concentrations exceeding cleanup levels. Metals, PCBs, PAHs, and dioxins have very low relative water solubility and low volatility, as discussed in Section 2.6.4, and pose low risk to groundwater

(Section 2.6.3). These constituents typically accumulate in soils and are typically considered soil/sediment contaminants rather than water contaminants. The low mobility of these constituents supports the use of capping as an acceptable method of reducing exposure risk. Capping would remove the likelihood of dermal exposure during most uses of the site. Due to their low mobility, the higher molecular weight PAHs, PCBs, and dioxins present in soil at the River Campus property are not expected to migrate to either the groundwater, other portions of the site, or off-site areas. Lead is the primary metal present at elevated concentrations in soils on site and also has low mobility in groundwater. Arsenic can have high mobility in groundwater, and was detected at a concentration slightly above site background (7.8 µg/kg compared to the site background level of 7 µg/kg) in the MIS sample from Area 2B in the depth range 0-1 foot. However, the very low exceedance of the background level in soils in Area 2B support the conclusion that no groundwater impact from these soils would occur due to arsenic.

5.4.2 Implementability

The capping option is technically feasible and readily implemented. All necessary service and materials are expected to be available. Capping is straightforward and done routinely at CERCLA sites. Qualified contractors are available to handle site preparation, equipment, personnel, services and materials, earthwork, and transportation. No off-site treatment is expected to be necessary. Clean soil used for the 2-foot cap is assumed to be available at a cost of $15/ton; however, a cheaper or free source of clean soil may also be available and would be considered during final planning for this option. The primary implementability issue is the availability of clean soil at the time of construction; however, soil availability is more of a timing and cost issue than a true constraint to implementability.

For most areas of the site, no obstacles to administrative feasibility are anticipated for this option. Statutory and permitting requirements, easements/rights of way and impacts on adjoining property are considered part of administrative feasibility. The property is owned in its entirety by the University of Portland, and no impacts to adjoining properties are anticipated. CERCLA response actions are exempted by law from the requirement to obtain federal, state, or local permits related to any activities conducted completely on site 42 U.S.C. § 9621(e). The CERCLA permit exemption applies only to CERCLA response actions, and does not apply to activities that occur off-site, such as disposal. However, response actions conducted on CERCLA sites must still meet or waive the substantive provisions of permitting and other regulations that are ARARs. The substantive requirements of Oregon permitting requirements for work on or near water and wetlands must be fulfilled as part of the selected removal alternative.

5.4.3 Cost

A summary of costs for Alternative 3 is provided in Tables 13 and 14 (for uplands and RS areas, respectively), which provide a cost breakdown by area as well as total cost. A detailed breakdown of costs by area is provided in Appendix C. If Option 3 is applied in all upland areas of the site where action levels are exceeded (whether occupational or residential), the total estimated cost would be $4,151,000. The costs to cap only the upland areas where active responses are needed (areas that exceed action levels based on exceeding an occupational or residential risk of 1E-4 or HI = 1) are $431,000. Capping of the DEQ ROD required areas will cost an additional $190,000. Alternative 3 does not apply to the river shoreline areas, as the RS areas are expected to require at least some excavation and will not be addressed by capping only. The costs for Option 3 are relatively high due largely to the cost of import of clean capping soil. The costs for clean imported soil was assumed to be $15/ton based on an average haul distance. If a cheaper or free source of fill soil can be found, the total cost of this option may be dramatically reduced. This could include using soil excavated from areas (RS-1, RS-2, and RS-3) in the uplands on site.

5.5 OPTION 4: EXCAVATION AND OFF-SITE DISPOSAL

Under Option 4, areas of the site that require a removal action for soil that exceeds cleanup levels would be excavated and disposed of off site at a permitted, confirmed, and approved disposal facility. The excavated areas would include:

- Uplands MIS areas that exceed the applicable occupational or residential-based risk thresholds;
- RS areas that exceed Portland Harbor PRGs or the applicable residential-based risk thresholds; and
- Hot spots areas.

A sub-option, Option 4A, is also considered. Under Option 4A, only soils exceeding action levels based on active response action thresholds (areas exceeding an occupational or residential risk of 1E-4 or HI = 1) would be excavated and removed (as well as hot spots and RS areas), as opposed to all soils exceeding action levels (active response action areas and limited action areas).

5.5.1 Effectiveness

Option 4 would meet the RAOs and make areas where this option is implemented “clean” and available for unrestricted use, meeting all requirements for UU/UE. The excavated area would not require institutional controls or long-term maintenance. If this action is chosen, it is assumed that remaining soils left in place would meet cleanup levels including those protective of residential use and that all material with concentrations of contaminants exceeding cleanup levels would be completely removed from the area. Option 4 would be effective in protecting human health and the environment under present and future land-use conditions, would comply with all potential ARARs, and would protect human health and the environment in both the short and long term. Because no contaminants above cleanup levels would remain in place with the excavated areas, no further risk of contaminant mobility nor impact to adjoining areas, such as the Willamette River, would be present. Option 4 is therefore expected to be highly effective in protecting human health and the environment.

5.5.1.1 Option 4A

Option 4A is essentially the same approach as Option 4; however, under Option 4A, only soils that require an active response (areas exceeding an occupational or residential risk of 1E-4 or HI=1) would be removed. In this scenario, some soils that exceed risk levels for residential and occupational exposure would not be excavated; and institutional controls would be needed. Option 4A protects all likely users of the site (recreational users, students, and campus workers) by removing or controlling through ICs all contaminants at concentrations likely to cause a risk to these receptors. This option is expected to be effective in protecting human health and the environment under present and future land-use conditions, since residential use would be prohibited. The option would also comply with all potential ARARs, and would protect human health and the environment in both the short and long term. However, long-term effectiveness would be lower than in Option 4, due to the need to maintain institutional controls over the life cycle of contaminant degradation. This option would therefore require long-term management.

5.5.2 Implementability

Removal Option 4 is technically feasible and readily implementable, and all necessary service and materials are expected to be available. Excavation and removal are straightforward, and many qualified contractors are available to handle site preparation, equipment, personnel, services and materials, excavation, disposal capacity, and transportation. No off-site treatment is expected to be necessary. Disposal facilities licensed to accept nonhazardous solid waste are available for all excavated soil. Clean soil used as backfill is assumed to be available at a cost of $15/ton; however, a cheaper or free source of clean soil may also be available and would be considered during final planning for this option. Due to the large volume of soil that would be removed during this option, the availability of clean backfill may represent an issue for timing, potentially increasing implementation schedule and/or costs.

No obstacles to administrative feasibility are anticipated for this option in any area of the site. Statutory and permitting requirements, easements/rights of way, and impacts on adjoining property are considered part of administrative feasibility. The property is owned in its entirety by the University of Portland, and no impacts to adjoining properties are anticipated. CERCLA response actions are exempted by law from the requirement to obtain federal, state, or local permits related to any activities conducted completely on site. The CERCLA permit exemption applies only to CERCLA response actions, and does not apply to activities that occur off site, such as disposal. However, response actions conducted on CERCLA sites must still meet or waive the substantive provisions of permitting and other regulations that are ARARs. Option 4 must meet the substantive requirements of the permits discussed in full for Option 3 (Section 5.4).

5.5.2.1 Option 4A

Option 4A, which assumes only soils above active response threshold risk levels are excavated, is similar in implementability to Option 4, except that institutional controls would be required. The implementability concerns outlined in Section 5.3.2 would therefore apply to this option.

5.5.3 Cost

A summary of costs for Option 4 is provided in Tables 13 and 14, which provide a cost breakdown by area and a total cost. A detailed breakdown of costs by area is provided in Appendix C. If Option 4 were applied to all upland areas of the site that require active responses (i.e., areas that exceed risk thresholds for both residential and occupational scenarios), the total estimated cost is an estimated $57,432,000. If RS areas are also excavated and disposed offsite, an additional estimated $8,686,000 will apply, assuming that the RS areas are excavated to a 4:1 slope (Table 14) and capped with clean soil.

The cost of this option is extremely high and is the highest of all options considered. The high cost of this option is primarily due to the high cost of disposal of contaminated soil ($65/ton). The cost of import of clean soil is also very high; however, if a cheaper or free source of clean soil could be identified, the costs of this option may be reduced somewhat.

The very high cost for this option is a significant impediment to successfully achieving the removal action objectives in a timely manner since UP anticipates that raising sufficient funds would be a challenge, and perhaps not possible.

5.5.3.1 Option 4A

Option 4A, which assumes that only soils requiring active responses (exceeding an occupational or residential risk of 1E-4 or HI=1) are excavated, is substantially less expensive than Option 4. Costs of this option would differ depending on whether clean soil is used as backfill and capping material, or soil is reused from excavations conducted on site. Under the clean soil scenario, if Option 4A were applied to all upland areas of the site, the total estimated cost is an estimated $6,905,000. Depending on the amount of soil from the RS areas that can be reused, the cost for excavation and disposal of soil exceeding active response threshold risk levels could be significantly reduced.

5.6 Option 5: Excavation and Re-Use of Soil On Site

Option 5 is a variation of Option 4. In this option, soils within the RS areas that require an active response due to the risk of shoreline soils eroding and migrating to the river are excavated, but instead of being disposed of offsite, these soils would be reused as backfill in other parts of the site. Implementation of Option 5 would possibly require temporary stockpiling (double handling of soils). Option 5 could be used only for soils that have COC concentrations that do not represent a risk to groundwater and are not above a regulatory limit, such as hazardous waste classifications under the RCRA or the Toxic Substances Control Act (TSCA). This option is designed to be used specifically for soils along the shoreline (Areas RS-1, RS-2 and RS-3) that have COC concentrations above the draft PH PRGs levels but that are generally not highly contaminated.

If relocated soils exceed risk-based threshold levels for the uplands, actions for placing these soils would need to be consistent with removal action decisions chosen for the uplands area where the soil was to be placed. Soil excavated from the RS areas as part of the removal action that exceed the cleanup levels for the uplands would need to be addressed consistent with the EE/CA decision for the uplands. Soils in the RS areas have only been characterized to a 10 ft depth and it may be necessary as part of design to evaluate the need for additional characterization or confirmation sampling depending on the grading required for this area for final development. **For example, if UP decides to develop the shoreline to improve habitat, the shoreline will be graded at a 4:1 slope**. This grading may or may not address all remaining contamination to acceptable levels. It is also possible that contamination above the cleanup levels for the shoreline area will extend deeper than will be needed to improve the habitat. In this case it may be necessary to evaluate other options such as capping.

5.6.1 Effectiveness

This option is expected to be effective as much of the soil present in the areas along the riverfront (Areas RS-1, RS-2 and RS-3) do not exceed active response action thresholds or potential cleanup levels that are likely to be applied to the upland areas and do not exceed levels that would present either a risk of migration to groundwater or levels that would require the soil to be disposed of offsite as hazardous waste. If soils exceed the cleanup levels and are excavated it is assumed they can be reused on site consistent with removal action decisions made for upland soils. Soils excavated from areas along the river and reused as backfill are not anticipated to present greater risk to human health or the environment than soils left in place in upland areas under the capping option (Option 3) or the institutional controls option (Option 2). This option would be effective in protecting human health and the environment.

5.6.2 Implementability

Soils excavated from areas along the river and reused as backfill would not be expected to present any additional technical or administrative implementability challenges compared to the capping and excavation options. Similar equipment and technologies would be used. Implementability issues include the likely need to temporarily stockpile the soil prior to final placement and the need for double handling of the material. An area on the site would need to be designated for stockpiling, and appropriate stormwater controls would need to be put in place to prevent mobilization of these soils during storm events while the stockpiles are maintained.

5.6.3 Cost

A summary of costs for Option 5 (excavation and reuse of soil onsite) is provided in Table 13, which provides a cost breakdown by area and a total cost. A detailed breakdown of costs by area is provided in Appendix C. If Option 5 were applied in areas RS-1, RS-2, and RS-3 of the site, the total estimated cost for excavation of those areas would be an estimated $1,431,000 assuming all soil can remain on site compared to a cost of $8,683,000 for Option 4 (excavation and offsite disposal for the RS areas). In addition to these direct savings for cleanup of the RS areas, reusing this soil will decrease backfill costs in the hotspot excavations, and some of this soil could also be used as capping material further reducing the cost of this option. Finally, the cost estimate has assumed that it would be necessary to temporarily stockpile soils from the RS areas as opposed to direct placement. If construction timing can be efficient, not all the RS Area soils would need stockpiling, resulting in additional cost savings. The reuse of stockpiled soils makes the cost of this option significantly lower compared to the options in which clean soil is uniformly used as backfill and in which affected soil is disposed off site.

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6.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION OPTIONS

This section presents a comparative analysis to evaluate the relative performance of each removal option in relation to the performance criteria (effectiveness, implementability, and cost). Key trade-offs affecting the final remedy selection are discussed. This comparative analysis identifies the advantages and disadvantages of each option relative to the others for each area of the site.

In order to consider the effectiveness, implementability, and cost of each option within different areas of the site, all of the subareas have been grouped based on action levels and the degree to which COC concentrations exceed these levels within each subarea. Based on these criteria, five groups of areas/subareas have been identified:

- **No action areas:** Areas where COC concentrations in soil do not exceed residential exposure threshold risk (cumulative risk of 1E-5, an HI of 1, or risk for an individual constituent of 1E-6, based on residential RSLs). No areas of the site met this criteria;
- **Limited action areas:** Areas where COC concentrations are below active response thresholds, but above levels that allow for UU/UE (cumulative risk of 1E-5, an HI of 1, or risk for an individual compound of 1E-6, based on residential or occupational RSLs): Areas 1C, 2A, 2A1, 2B, 3B (including subareas 3B1, 3B2, 3B3, and 3B4), 5A, 5B, 6A, 6B, 6C, 6D1, 6D2, 6D3, as indicated in Table 8; Areas with areas considered not to exceed threshold risk, but where undetected COCs in soils have detection limits exceeding residential RSLs include: Areas 1A, 3A, 4, and individual depth units for other areas, as indicated in Table 8;
- **Active response action areas:**
  - Upland areas where COC concentrations in soil exceed active response levels (exceeding an occupational or residential risk of 1E-4 or HI=1): Area 1B ;
  - Areas along the riverfront where COC concentrations in soil exceed draft PH PRGs: Areas RS-1, RS-2, and RS-3; and
- **Hot spots.**

The No Action alternative (Option 1) would not be effective in addressing removal action objectives and will therefore not be considered further in this comparative analysis. The remaining alternatives are:

- Option 2: Institutional controls;
- Option 3: Capping;
- Option 4: Excavation and off-site disposal; and
- Option 5: Excavation and re-use of soil on site.

The use of each option or combination of options is assessed for each of the groups of site areas.

Criteria for the comparative analysis are based on EPA guidance (EPA, 1993).

6.1 AREAS WITH SOILS BELOW RESIDENTIAL RISK

Three areas of the site (1A, 3A, and 4) as shown in Table 8 are not considered to exceed residential threshold risk (residential cumulative risk of 1E-5, an HI of 1, or an individual compound exceeding residential risk of 1E-6, using residential RSLs) based on detected constituents. However, some undetected COCs in these areas have detection limits exceeding residential RSLs. No active response action is warranted in these areas; however, due to uncertainty regarding the exact concentration of COCs in these areas, they will be considered to require a limited action of institutional controls. Further characterization of soils in these areas could be considered in order to obtain additional information on the nature and extent of COCs in these soils. However, with institutional controls in place, no risk to human health or ecological risk is anticipated in these areas.

6.2 AREAS WITH SOILS EXCEEDING RESIDENTIAL OR OCCUPATIONAL RISK BUT BELOW ACTIVE RESPONSE THRESHOLD LEVELS

The following areas have soils with COC concentrations exceeding action levels based on residential and occupational risk thresholds, but are below active response threshold levels based on concentrations exceeding an occupational or residential risk of 1E-4 or HI=1: Areas 1C, 2A, 2A1, 2B, 3B (including subareas 3B1, 3B2, 3B3, and 3B4), 5A, 5B, 6A, 6B, 6C, 6D1, 6D2, 6D3, RS-1, RS-2, and RS-3, as well as selected depth units of other areas as indicated in Table 8.

6.2.1 Effectiveness

Effectiveness addresses overall protection of human health and the environment; compliance with ARARs; long-term effectiveness; reduction of toxicity, mobility and volume; and short-term effectiveness.

All the options except Option 1 (No Action) are expected to be protective of human health and the environment for areas with soils exceeding residential risk-based threshold levels and soils exceeding the occupational risk-based thresholds but less than the active response threshold. All the options except Option 1 prevent residential use on the site or prevent people from coming into contact with these soils. If institutional controls (Option 2) are used as the sole remedy, human users may come into contact with soils containing concentrations of COCs exceeding action levels. However, if the institutional controls prevent residential use, risk is anticipated to be low since the majority of the site will be developed and covered with ballfields, parking lots, sidewalks, buildings, or landscaping and site use will be controlled through ICs. Since the exposure to contaminated soils with concentrations below the active response threshold are limited due to the planned site development, the institutional controls option (Option 2) is therefore as effective as other options.

Compliance with ARARs differs for each of the options for these areas. Option 3 (capping) and Option 5 (excavation and re-use of site soils from near the river as capping material in uplands areas) would comply with ARARs only for surface soils; soils exceeding residential and occupational threshold risk levels would remain, but would be capped by 2 feet of clean soil or an equivalent cap. Institutional controls would still need to be included with these options to prevent exposure to underlying soils at any time in the future. Under Option 2 (institutional controls only), surface soils would remain with concentrations of COCs above residential and occupational threshold risk levels. However, with institutional controls in place, the soils in these areas would meet all potential risk-based ARARs for expected users of the site. Option 4 is considered most effective at complying with potential ARARs, because all soil exceeding residential levels would be removed completely from the site.

All the options are considered likely to be effective in the long term. However, the relative long-term effectiveness of the options differs slightly. The most effective option over the long-term would be Option 4, since soils would be completely removed from the site, and there would be no risk to site receptors even if residential use were permitted. Options 3 and 5 are considered the next most effective over the long term, as contaminated soils would remain on site and be managed accordingly and would require institutional controls. Option 2 (institutional controls) may appear less effective than Options 3 and 5 but is nevertheless considered equally protective. Institutional controls would prevent residential development and control use for the soils posing lower risk and, therefore, this option is protective of human health and the environment.

No option considered in this EE/CA provides an absolute reduction in total toxicity, mobility, or volume of COCs in soils. Soils would contain the same contaminant concentrations and volume even if moved off site, where they would need to be managed at the disposal facility. This consideration suggests that if the soils can be managed effectively on site without risk to site receptors, this may be preferable to adding increased volume to a disposal facility such as a landfill. Off-site disposal of soils would reduce the mobility of contaminated soil by moving the soil to a disposal facility that prevents contaminant migration. An off-site facility would also eliminate the management issues of contaminated soils (administrative issues associated with ICs). The COCs present in those site soils exceeding only residential screening levels but not the active response threshold of 1E-4 occupational risk or HI=1 (metals, PCBs, dioxins, and heavy PAHs) are considered to have low mobility due to their chemical properties. Migration of these COCs from soils at the site is considered unlikely and management requirements for institutional controls would be minimal.

All options are considered equally effective for these areas in the short term, during construction and implementation. Short-term exposure to COCs exceeding only residential screening levels is not considered a health risk to likely short-term receptors, such as construction workers and disposal crews.

Few differences in effectiveness are anticipated between the four options being considered for areas of the site that exceed residential threshold risk levels but do not exceed the action levels based on occupational site use. If Option 3 (capping) or Option 5 (re-use of site soils for capping) is used for these areas, potential site ARARs would not be met and these options would need to be combined with institutional controls (Option 2). ICs would involve a proprietary control preventing residential development, which could also be used as a sole remedy for these areas. Option 4 (excavation) is slightly more effective than all other options in meeting all potential site ARARs and in long-term effectiveness, as all soils above the most conservative cleanup level (the residential action level) would be completely removed from the site, allowing for UU/UE.

6.2.2 Implementability

Implementability includes technical feasibility, administrative feasibility, and the availability of necessary resources to support the alternative.

For areas exceeding only the residential and occupational risk threshold, but not the active response threshold, Option 2 (institutional controls) is most technically feasible as no equipment or construction is necessary to implement this option. Institutional controls may, however, be difficult to maintain over a long period of time, which includes the period required for contaminants to degrade below a risk threshold. Since the compounds present at the site break down extremely slowly in the natural environment, the time period should be considered at least 100 years. Permanent structures (such as a building or parking lot) may aid in demarcating areas with institutional controls. Options 3 (capping) and 5 (re-use of excavated site soils for capping) are the next most technically feasible options, as the only requirement would be the import and/or excavation and transport of backfill soil. Option 3 would require identification of a clean soil source, which may present an obstacle to technical feasibility. Option 4 (excavation) is least technically feasible as it requires the excavation, transport, and disposal of massive quantities of soil. Public safety and nuisance would result from both Options 3 (capping) and 4 (excavation and off-site disposal) due to truck and equipment traffic in the neighborhood and through the campus.

Administratively, Option 2 (institutional controls), is most implementable for these areas. Proprietary institutional controls are routinely placed on contaminated sites using standard forms developed by both EPA and DEQ. Specifically proprietary control would be in the form of a EPA and DEQ-approved *Easement and Equitable Servitude* (EES) pursuant to Oregon State law. The EES would identify the site remedy and ongoing management requirements on the property deed and would be enforceable by DEQ and/or EPA. A DEQ-approved *Soils Management Plan* would also be developed that would address long-term operation and maintenance requirements. Administrative implementation of Options 3, 4, and 5 would require that the substantive components of permits for waterfront development be met (Section 5.4.2). No substantive differences are present in administrative feasibility between these options.

Services and materials are considered to be available for all the options. Option 2 (institutional controls) is the only option that requires no construction-related services and materials.

In summary, Option 2 (consisting of institutional controls preventing residential development) is the most implementable option for areas exceeding limited action risk criteria. Options 3 and 5 are fairly similar to one another in implementability and are not expected to pose major implementation obstacles for these areas. Option 4 is the least implementable option due to the requirement for import, transport, and disposal of large amounts of soil and the safety considerations of truck traffic.

6.2.3 Cost

Cost estimates for the different options for these areas are summarized in Tables 13 and 14; a detailed breakdown of cost estimates is presented in Appendix C. In summary, the cost of each option is as follows:

- Option 2 – Institutional Controls: $50,000 to implement which is negligible compared to other options plus all other options except Option 4 would require institutional controls;
- Option 3 – Capping of material exceeding threshold risk levels based on residential exposure is an estimated $4,151,000;
- Option 4 – Excavation and offsite disposal of material exceeding residential and occupational-based threshold risk levels is on the order of approximately $57,432,000 for upland areas, with an additional $8,683,000 for RS areas;
- Option 5 – Excavation with re-use of site soils from the RS Areas as backfill and capping material could reduce overall project cleanup costs by as much as $8 Million. The costs of this option cannot be directly compared to other options since this option, really only applies to the RS areas and is not appropriate for the upland areas.

These costs do not include the additional required action to comply with the DEQ ROD. These include $190,000 for capping and $568,000 for hot spot excavation. The most cost-effective option is Option 2, followed by Option 3, Option 5, and Option 4; however, the cost differential between Option 2 and the other options is significant.

6.2.4 Summary and Recommendation

For areas with concentrations of COCs exceeding residential and occupational threshold risk levels but lower than active response threshold levels based on exceeding an occupational or residential risk of 1E-4 or HI greater than 1, there is little meaningful difference in effectiveness among the options. All active options are considered to be effective in protecting human health and the environment in these areas over both the short and long term. However, Option 2 (institutional controls to prevent residential development) is considered much more implementable and can be implemented for a much lower cost than other options. Option 2 is therefore recommended for Areas 1C, 2A, 2A1, 2B, 3B, 5A, 5B, 6A, 6B, 6C, 6D1, 6D2, 6D3 and, soils from river shoreline Areas RS-1, RS-2,and RS-3, if reused in the uplands areas, as they exceed cleanup levels based on residential and occupational use but do not exceed levels based on active response action levels (exceeding an occupational or residential risk of 1E-4 or HI greater than 1).

6.3 Upland Areas With Soils Exceeding Active Response Levels

The following upland area has soils with COC concentrations requiring action based on calculated risk using active response levels (exceeding an occupational or residential risk of 1E-4 or HI=1): Area 1B. This area is deemed to require an active response action (EPA, 2011b).

6.3.1 Effectiveness

For areas of the site where concentrations of COCs in soils require action based on active response criteria, Option 2 (institutional controls only) is not expected to be sufficiently protective of likely users of the site, including campus employees, students, campus visitors, and recreational users. In addition, institutional control used as a sole remedy would not meet potential site ARARs. Option 2 is therefore not considered further for this group of areas, except in that institutional controls are used in conjunction with other options.

In general, if soils in an area contain COC concentrations above the action levels based on exceeding an occupational or residential risk of 1E-4 or HI=1, one of the more active removal action alternatives will be required to eliminate unacceptable risk (Options 3, 4A, or 5). Capping may not provide sufficient protection if COC concentrations are sufficiently greater than action levels and COCs represent a risk for mobility to groundwater or air (soil vapors). At the site, the only areas that represent such a risk are within the identified hot spots. All the MIS areas are impacted with constituents that have very low mobility in the environment, and capping would sufficiently address the direct contact risks.

Options 3 (capping), 4A (excavation and offsite disposal for soils that exceed cleanup levels based on active response threshold [exceeding an occupational or residential risk of 1E-4 or HI greater than 1]), and 5 (re-use of site soils) are each effective in overall protection of human health and the environment for these areas. These options would all prevent exposure of site receptors to surface soils containing concentrations of COCs above cleanup levels based on active response threshold (exceeding an occupational or residential risk of 1E-4 or HI greater than 1). These three options all include the need for institutional controls.

Option 5 (excavation and re-use of soils from river shoreline areas [RS areas]) could be used in conjunction with either Option 4A (excavation and off-site disposal for soils above cleanup levels based on exceeding the active response threshold with an occupational or residential risk of 1E-4 or HI greater than 1) or Option 3 (capping) for these areas. Option 3 (capping) and Option 5 (excavation and re-use of site soils) would leave soil in place that do not meet potential ARARs without additional controls. Institutional controls imposed in conjunction with these options to prevent exposure of users of the site to soils would meet potential ARARs. These options would still require the use of institutional controls, a soil management plan, and a hazard communication plan in case of future construction that could expose these soils. Option 4A (excavation and offsite disposal) would remove all soils that exceed cleanup levels based on exceeding the active response threshold with an occupational or residential risk of 1E-4 or HI greater than 1, and is therefore more effective than the other options with regard to assuring potential ARAR compliance.

All the options are considered to be effective in the long term. However, Options 3 and 5 have the potential to be less effective over the long term, since a clean soil cap over soils exceeding active response thresholds could erode or be damaged over time and would require maintenance, including annual inspections. In addition, institutional controls would be necessary to prevent exposure of site users to these soils in the case of future construction or other subsurface activity. The most effective option over the long-term would be Option 4A, since soils in exceedance of cleanup levels would be completely removed from the site and there would be no risk to site receptors under any future-use scenario for the site.

As discussed in Section 6.2.1, no option considered in this EE/CA provides an absolute reduction in total toxicity, mobility, or volume of COCs in soils, as the soils will contain the same contaminant concentrations and volume even if moved off site. Thus, soils managed effectively on site without risk to site receptors is preferable to adding increased volume to a disposal facility such as a landfill. COCs present in soils exceeding occupational use risk levels (metals, PCBs, dioxins, and heavy PAHs) are considered to have low mobility due to their chemical properties. Migration of these COCs from soils at the site is considered unlikely.

All options considered for these areas are equally effective in the short term, during the construction and implementation phase. Construction workers, disposal crews, and other site workers have the potential to be exposed to soils exceeding recreational and commercial/industrial screening levels under all the options and should take necessary precautions. These precautions include wearing appropriate personal protective equipment and following short-term institutional controls established during the implementation phase. Option 4A, which requires excavated soil to be disposed of offsite, would result in high volumes of truck traffic through the campus and neighborhood increasing the risk of accidents involving the public.

In summary, Option 2 (institutional controls only) is not considered an effective remedy for these areas. If Option 3 (capping) or 5 (excavation and re-use of site soils) is used for these areas, these options both assume the need for institutional controls for long-term effectiveness. Option 4A (excavation and off-site disposal) is slightly more effective than all other options in meeting all potential site ARARs and for its long-term effectiveness, as all soils above occupational threshold risk levels would be completely removed from the site.

6.3.2 Implementability

Options 3 (capping) is the most technically implementable, as the only requirement is the import of clean capping soil. Availability of clean soil in the volumes required may represent a scheduling obstacle as large volumes of clean soil may not be immediately available; however, alternative caps, such as use of parking lots or buildings, could greatly reduce the need for imported soil. Option 4A (excavation and off-site disposal for soils that exceed cleanup levels based on exceeding the active response threshold of an occupational or residential risk of 1E-4 or HI greater than 1) is the least technically feasible as it would require the excavation, transport, and disposal of large quantities of soil and still require a massive clean soil source for backfilling the excavation. The truck traffic for Option 4A through the campus and neighborhood would likely be viewed by the public as a major inconvenience and a safety and noise hazard. Services and materials are considered to be generally available for all the options.

Administratively, Option 3 (capping) and 5 (excavation and reuse of soil) would require institutional controls. Administrative implementation of all the options considered for these areas (Options 3, 4A, and 5) would additionally require that the substantive components of permits for waterfront development be met (Section 5.4.2).

Options 3 and 5 are fairly similar in implementability and are not expected to pose major implementability obstacles for areas where soils exceed occupational threshold risk levels. Since Option 5 (excavation and reuse of soil) would provide soil that can also be suitable for capping, Options 3 and 5 are somewhat complementary options. Option 4A (excavation and off-site disposal of soils that exceed cleanup levels based on exceeding the active response threshold of an occupational or residential risk of 1E-4 or HI greater than 1) is the least implementable option due to the requirement for import, transport, and disposal of large amounts of soil and the impact on the neighborhood residents due to the high volume of truck traffic.

6.3.3 Cost

Cost estimates for the different options for these areas are summarized in Tables 13 and 14; a detailed breakdown of cost estimates is presented in Appendix C. In sum, the cost of each option is as follows:

- Option 2 – Institutional Controls: Not considered for these areas;
- Option 3 – Capping of soil exceeding cleanup levels based on the active response threshold with an occupational or residential risk of 1E-4 or HI greater than 1for the upland soils: $431,000;
- Option 4A – Excavation and offsite disposal of soil exceeding cleanup levels based on the active response threshold with an occupational or residential risk of 1E-4 or HI greater than 1; $6,905,000.
- Option 5 – Excavation with re-use of site soils from the RS areas as backfill could reduce the cost of backfill material required in the Uplands Area where Option 4A is being implemented. This reuse of soil could reduce the costs of Option 4A by approximately $9 per ton (i.e., approximately $342,000 for re-use of the 38,000 tons assumed to be excavated from the RS areas).

The most cost-effective option is Option 3, followed by Option 5 and then Option 4A.

6.3.4 Summary and Recommendation

For areas with soils having concentrations of COCs exceeding cleanup levels based on based on the active response threshold with an occupational or residential risk of 1E-4 or HI greater than 1 , the use of Option 2 (institutional controls) as a sole remedy is not an effective option and has been removed from further consideration. The remaining Options 3, 4A, and 5 are considered effective in protecting human health and the environment in these areas over both the short and long term. However, Options 3 and 5 would need to be combined with institutional controls to ensure long-term effectiveness. Option 4A is less technically implementable and much more expensive than the other options.

A combination of Options 3 and 5 is recommended for these areas based on cost and implementability. It is recommended that the areas be capped, re-using stockpiled soils excavated from the riverfront areas for backfill where feasible. The cost specified above for capping assumes imported material is used for capping. If excavated soils from the riverfront can be used for some of this capping material, costs for imported fill would be reduced. Institutional controls would be required for both Options 3 and 5.

For areas of the site where Option 3 (Capping) is used, the preference should be, where possible, to use an alternative form of cap, including asphalt parking lots, building foundations, and sports fields. These types of caps require less maintenance, are less likely to result in accidental penetration, and are more definable to the public. Figure 13 shows the current proposed plan for development of the UP River Campus area (the site) and the areas that will likely be capped by an alternative cap versus a soil cap. Although the exact location of these alternative cap locations may change with long-term planning, this layout shows the approximate extent of alternative caps that may be placed.

6.4 River Shoreline Areas

The draft Portland Harbor PRGs Values for Soil/Stormwater Sediment (EPA and DEQ, 2007, Table 3.1) are considered a potential ARAR for the site that must be applied in the EE/CA for all decision unit areas that border the Willamette River (i.e., RS-1, RS-2, and RS-3). Contaminated soils in these areas present a greater potential for migration to the river sediments. Soil in the shoreline area that is known to be above the draft PH PRGs need to be addressed. Soil removed from the shoreline area that meets uplands area cleanup levels based on the active response threshold with an occupational or residential risk of 1E-4 or HI greater than 1 can be reused as backfill in upland areas consistent with decisions made for uplands areas. \

Given the sensitivity of the river shoreline areas, it is assumed that Option 4 (excavation and off-site disposal) or Option 5 (excavation and on-site re-use) will be used where appropriate. Clean soil may be used as backfill if required. Capping (Option 3) combined with excavation could also be appropriate assuming that the combination of excavation and capping eliminates the risk of migration of COCs to the river sediments. The remaining options are not considered to be effective for these areas as they are not likely to meet the draft PH PRGs if implemented individually.

Cost projections for both Option 4 and Option 5 assume that the three RS areas would be excavated to a depth of 10 feet below existing grade, or to a slope of 5:1 based on the University's preliminary discussions with NOAA Fisheries and anticipated mitigation measures for potential ESA impacts. Cost estimate for excavation of the RS areas are shown in Table 14. The shoreline would be altered from the existing near-vertical bank to a bank sloped to a gradient of 5:1 horizontal to vertical, as shown in Figure 14. Capping could be used in combination with Option 4 or Option 5. Specifically, if excavation removes soil to below a depth of 10 feet but contaminated soil still remains above draft PH PRGs, capping can be used to eliminate the soil to surface water pathway. It is not known at this time if capping will be necessary, but that scenario could be identified during design or upon obtaining confirmation samples during implementation.

Estimated costs for Option 4 and Option 5 for the riverfront areas are presented in Table 14; a detailed breakdown of cost estimates is presented in Appendix C. Total cost for excavation and off-site disposal of the excavated soil for the three RS areas as described above is $8,683,000, assuming excavation to a 5:1 slope. If the material excavated is re-used as backfill or cover material in the uplands (disposal costs not incurred) then the cost would be reduced to approximately $1,431,000.

6.5 HOT SPOTS

A total of 17 potential hot spot areas were evaluated in Section 2.6.2 regarding the need for removal action. The locations of the hotspot areas are shown on Figure 5. Of those, eight potential hot spot areas are expected to require an active response action based on the on the 2005 ROD and/or on the concentrations of COCs present. Additionally, 17 areas require capping to meet requirements of the DEQ ROD.

Six of the hotspot areas were identified in the ROD as areas planned for excavation (Section 2.6.1.1). These six hot spots are presumed to require excavation and off-site disposal to meet requirements of the 2005 ROD.

Additional potential hot spots were identified as requiring an active response action based on review of available data (Section 2.6.1.2). One of these areas (an area of stained soil in Area 5A) met the Oregon state definition of *hot spot,* and the preferred remedy for this area is excavation and off-site disposal. The second area (Area WS-3A-2a), while not fitting the definition of a hot spot, exceeds residential screening levels in an area that otherwise has been found only to have undetected constituents above RSLs (Area 3A). This area will therefore likely require a minimum of institutional controls. Other potential hot spot areas that were designated during the MIS sampling as "waste" areas were determined not to be hot spots and will be managed consistent with the MIS areas. Specifically several areas have concentrations below residential risk levels and require no action, and the remaining areas have been included within the MIS areas for actions.

The six areas identified for excavation in the ROD (A2-1, A2-3, A5-11, A5-12A/B, A5-13, and A4-5) will be excavated and backfilled. The portion of A5-12A/B located within RS-2 area and partly in upland area 5A, does not meet the definition of a hot spot but is above cleanup levels relative to draft PH PRGs for the shoreline portion. The single non-ROD specific hot spot (the stained soil under the slab in Area 5A) is also assumed to require excavation and disposal off-site (Option 4).

Under Option 4 (excavation and off-site disposal), backfill may be either clean, imported soil or re-used soil that has been excavated from areas along the river (Option 5). The decision to excavate or cap hinges in part on the mobility and concentration of the COCs present in these soils. In general, the hot spot areas are deemed source areas with high concentrations of COCs representing a risk to groundwater and off-site migration of COCs. In some cases the COCs are limited to one or two low-mobility COCs, and capping is a demonstrated effective alternative to excavation. Additionally, 17 hotspots will be capped with 2 inches of asphalt in accordance with the 2005 ROD.

The effectiveness, implementability, and cost of various options to address the hot spot areas are compared in this section.

6.5.1 Effectiveness

Hot spots are areas that have been identified as representing a possible source area of contamination with high concentrations of COCs. For the areas where elevated concentrations of COCs are present, capping or excavation will be required to eliminate the risk. Capping may not provide sufficient protection if the COC concentrations are sufficiently high that COCs represent a risk for mobility to groundwater or air (soil vapors). Excavation will likely be required in these areas. However, capping (Option 3) is anticipated to be an effective option in other cases, especially in the hot spot not previously identified in the DEQ 2005 ROD, and for several hot spots identified as requiring capping under the 2005 ROD.

Option 5 (re-use of soils from areas along the river) could be used in conjunction with either Option 4 (total excavation) for the hot spots as soils from the shoreline area could potentially be used as backfill. This combination of removal action approaches is an effective option in overall protectiveness of human health and the environment. The effectiveness of using stockpiled soils has been described in earlier sections.

The use of Option 3 (capping) would leave soil in place that does not meet potential ARARs. Institutional controls would therefore need to be used in conjunction with these options to prevent current or future exposure of users of the site to soils exceeding potential ARARs. Institutional controls, including an EES and/or hazard communication plans, could be used in case future construction occurs that could expose these soils. However, soils in the hotspot areas could represent a risk of contaminant mobility; therefore Option 3 as a sole remedy for the hotspots is not considered effective at meeting Removal Action Objectives. Option 4 (excavation) would remove all soils exceeding potential ARARs from the site, and is therefore more effective than the other options with regard to meeting potential site ARARs at hot spots.

Only Option 4 (excavation and offsite disposal) and Option 4 combined with Option 5 (re-use of suitable soil from the shoreline area as backfill) are considered likely to be effective in the long term. The most effective option over the long-term would be Option 4, since soils in exceedance of cleanup levels would be completely removed from the site and there would be no risk to site receptors under any future use of the site.

Remaining comparative considerations for effectiveness are similar to those discussed in earlier sections of this EE/CA.

6.5.2 Implementability

The implementability of the options for the hot spot areas is similar to implementability considerations described under Section 6.2.2.

6.5.3 Cost

Cost estimates for the different options for these areas are summarized in Table 13; a detailed breakdown of cost estimates is presented in Appendix C. The projected cost of each option is as follows:

- Option 2 – Institutional Controls: Does not meet RAOs as a stand alone option;
- Option 3 – Does not meet RAOs as a stand alone option and does not alone meet commitments in DEQ ROD ($190,000 to cap ROD required areas);
- Option 4 – Excavation of ROD hot spots $568,000;
- Option 4 –the additional hot spot (stained soil) and area WS-3A-2A, which exceeds uplands cleanup levels based on residential use: $81,000.

6.5.4 Summary and Recommendation

Table 15 provides a detailed description of removal actions recommended for each hotspot area. For hot spots, Option 2 (institutional controls) is not appropriate due to the high concentrations of COCs and the threat of mobilization of COCs to groundwater and ultimately to the Willamette. Similarly by definition, hot spots may not be containable and they may have COCs mobile in groundwater. As a result, Option 3 (capping) is not considered effective in meeting removal action objectives, except for areas specified in the 2005 DEQ ROD as requiring only capping. For this reason, only Option 4 (excavation of off-site disposal) is considered effective for the majority of hot spots and this option is also consistent with the DEQ ROD. Soils from the river shoreline areas could be used as backfill (Option 5) following implementation of Option 4. However, area WS-3A-2A, which does not fit the definition of a hot spot but is located in an MIS area that otherwise exceeds site criteria only due to undetected constituents with detection limits above RSLs, will require institutional controls.

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7.0 RECOMMENDED REMOVAL ACTION

This section summarizes, for each designated area and subarea of the site, the recommended removal action. A complete comparative analysis of alternatives for each area was provided in Section 6. In recommending an action from the various available alternatives for each area, several factors were considered. First, each recommended action was considered in light of effectiveness, implementability, and cost. Second, on-site management of soils was preferred when possible, so long as such management would remain highly protective of human health and the environment. On-site management is preferred because it would minimize the neighborhood nuisance and safety concerns of transport to and storage at a disposal facility/landfill, where the soils would continue to require long-term management and maintenance.

Table 16 summarizes the recommended alternative and the cost of the recommended alternative for each area. The recommended alternative is described below for each subset of site areas:

- **Upland Areas:** where soils do not exceed any action levels, but contain undetected COCs with detection limits above residential RSLs (Areas 1A, 3A, and 4, as indicated in Table 9): Due to uncertainty regarding the exact concentrations of constituents in these areas, institutional controls are the recommended action.
- **Limited Action Areas:** In these areas, soils exceed action levels based on residential or occupational exposure but do not exceed active response action levels based on an occupational or residential risk of 1E-4 or HI = 1 (Areas 1C, 2A, 2A1, 2B, 3B [including subareas 3B1, 3B2, 3B3, and 3B4], 5A, 5B, 6A, 6B, 6C, 6D1, and 6D2, and 6D3 as indicated in Table 9). Institutional controls (Option 2), consisting of an EES that would prevent residential development, is the recommended alternative for these areas. This alternative is recommended because it poses significantly fewer obstacles to implementability and is much less expensive than other options considered in this EE/CA. In addition, compared to other options, this alternative is considered equally effective in protecting human health and the environment over both the short and long term. UP is not proposing to use the site for residential use and plans to cover much of the property as part of future redevelopment. Therefore, leaving soils in these areas is consistent with the planned site use where risk is based on occupational use. Institutional controls provide equal protection of human health and the environment without the construction risks and costs of more aggressive actions.
- **Active Response Action Areas:**
  - **Upland Areas where soils exceed action levels based on risk of 1E-4 or HI=1** (Area 1B,): A combination of capping (Option 3) and re-use of excavated site soils (Option 5) is recommended for this areas, based on cost and implementability (Table 16). It is recommended that the area be capped with 2 feet of clean soil, re-using stockpiled soils excavated from the riverfront for any required backfill and for capping where soils meet cleanup levels based on the active response threshold with an occupational or residential risk of 1E-4 or HI greater than 1. If the planned future use of an area includes placement of an equivalent cap, such as a building or parking

lot, this alternative cap will be proposed in lieu of a soil cap as part of cleanup design. This recommended action will need to be combined with additional institutional controls in order to maintain long-term effectiveness. However, with institutional controls in place (such as an EES, a soil management plan, a hazard communication plan, and monitoring and maintenance of the cap), this alternative is considered equally protective of human health and the environment over both the short and long term compared to other options.

- **Areas along the waterfront where draft Portland Harbor PRGs cleanup levels apply** (Areas RS-1, RS-2, and RS-3): A combination of excavation of soil (Option 4) with re-use of the soil that is below upland cleanup levels on site (Option 5), and potential capping (Option 3) is the recommended alternative for river shoreline areas of the site. Clean, imported soil will be used as backfill as required to meet ESA requirements. It is assumed that most of the soil along the riverbank will be removed to eliminate potential migration of COCs from the shoreline into the river and river sediment. Applying the draft Portland Harbor PRGs as cleanup levels for these areas eliminates the other options. Soil from Areas RS-1, RS-2, and RS-3 should be compared to upland cleanup levels based on the active response threshold with an occupational or residential risk of 1E-4 or HI greater than 1 and used in the uplands to the degree such use is consistent with decisions made for the uplands. Soils that do not exceed risk thresholds may be used as backfill or cap material in upland areas of the site (Option 5). If used as backfill or cap material in upland areas, institutional controls will be established to prevent unacceptable use and limit disturbance of capped areas. Capping within the RS areas may be used in combination with excavation if soils above Portland Harbor PRGs or other cleanup levels are left in place.

- **Potential excavation areas (hot spots):** Hot spots by DEQ definition are source areas that have high COC concentrations (10 to 100 times screening levels) and therefore present a risk of mobility of COCs to groundwater. The recommendations for removal action are presented on a case-by-case basis for each hot spot in Table 15, and the estimated cost for the recommended action for each hot spot is shown in Table 16. Hot spots identified in the DEQ 2005 ROD are required as a condition of the ROD to be excavated and the soils disposed of off-site (Option 4). The only additional hot spot not identified in the 2005 ROD presents similar concerns of COC mobility, since it fits the DEQ definition of a hotspot, and as such is recommended to be excavated and removed for off-site disposal (Option 4). Additionally the DEQ 2005 ROD identified 17 hot spot areas for capping only. These areas will be capped as prescribed in the ROD.

It should be noted that, except for area 1B, the RS and hot spot areas most of the site will only have ICs; however, while not part of the CERCLA response action(s), further development of the site by UP will result in construction of buildings and hard surfaces such as sidewalks and parking lots that will serve as effective barriers to prevent exposure to or migration of any residual soil contamination. In anticipation of such redevelopment, the eventual site ICs and/or O&M plans will specify that proper health and safety precautions be taken by workers, that no action be taken that could compromise the integrity of the remedy where waste is being contained or managed in place on site, and best management practices be used to minimize the release, spread or exposure to soils with residual contamination

Total estimated costs to implement the proposed removal actions described above are $3,584,000.

The final recommended alternative for each area will be selected by EPA after an opportunity for input from stakeholders and the public comment period of at least thirty days in accordance with the NCP.

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8.0 SCHEDULE

UP plans to complete the removal action process, including implementation of the final removal action, as soon as practical given the constraints of the process and the University's ability to fund future development. The University seeks to confirm as soon as possible the likely future costs of removal and thereby focus its fund-raising efforts to complete both the cleanup and subsequent development.

Once EPA approves the EE/CA and issues it for public review and comment, and then EPA issues the Action Memorandum selecting the removal action, consistent with the Statement of Work attached to the Order, UP will submit a draft *Conceptual Design Report* within 60 days of EPA's signature on the Action Memorandum. UP hopes to begin implementation in spring 2012.

At the present time, implementation of the entire proposed removal action in a single action starting in 2012 will not be possible by UP due primarily to budget constraints, the need for adoption of University Master Plan updates, and approval of development plans by the City of Portland. To accommodate several major new developments on its upper bluff campus (library expansion in 2012 and a new Recreation/Wellness Center ground-breaking in 2013), UP plans to construct a new sports practice field with associated paved parking areas on the northern and northwestern end of the River Campus property beginning in the spring of 2012. In addition, UP has begun discussions with its Athletic Department administrators to finalize plans to begin construction of a new NCAA Division 1 baseball field in the northwest quadrant of the River Campus in the summer of 2012. The field will be enhanced with lighting, outfield fences, batting facility, team dugouts, temporary bleacher seating, and adjacent paved parking lots. UP hopes to have the new baseball field and other amenities ready to host practices and games by the summer of 2013. Construction of a new baseball stadium with permanent seating would hopefully follow in 2 to 3 years, depending on the availability of funds.

Other projects envisioned by UP in the first 1-3 years following EE/CA approval include paved parking areas in the northeast quadrant of the River Campus, concrete pads marking potential future siting and construction of a Physical Plant complex involving several new buildings, and additional athletic-related facilities. All of the projects mentioned above are intended for areas of the River Campus where removal actions are expected and in which UP hopes to initiate activity early in 2012. The conceptual vision plan UP has produced for its River Campus is designed to phase new development activities to match the availability of funds with a goal of 50 percent to 75 percent completion within 10 to 15 years of final EE/CA approval.

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TABLES

FIGURES

APPENDIX A

Re-Use Assessment

APPENDIX B

Applicable or Relevant and Appropriate Regulations

APPENDIX C

Detailed Cost Analysis